4

1-80

elektor

79

November 1981

U.K. 65p.

up-to-date electronics for lab and leisure

Metal detector
sophistication in practice.

Hand-held frequency counter
up to 40 MHz.

Mini organ
with maxi sound.

TTLs TEXAS

7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
74S04	90p
7405	18p
7406	30p
7407	30p
7408	16p
7409	16p
7410	15p
7411	40p
7412	20p
7413	25p
7414	35p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	25p
7425	30p
7426	30p
7427	25p
7428	30p
7430	17p
7432	30p
7433	30p
7437	30p
7438	30p
7440	17p
7441	70p
7442A	50p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	60p
7448	60p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	30p
7474	25p
7475	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483A	50p
7484	100p
7485	90p
7486	30p
7489	210p
7490A	30p
7491	60p
7492A	40p
7493A	30p
7494	84p
7495A	60p
7496	50p
7497	140p
74100	85p
74104	65p
74105	65p
74107	34p
74109	40p
74110	55p
74111	70p
74116	90p
74118	75p
74119	90p
74120	70p
74121	28p
74122	48p
74123	50p
74125	40p
74126	40p
74128	40p
74132	45p
74136	32p
74141	80p
74142	200p
74145	70p
74147	100p
74148	75p
74150	100p
74151A	45p
74153	50p
74154	80p
74155	60p
74156	60p
74157	50p
74159	100p
74160	60p
74161	60p
74162	60p
74163	60p
74164	90p
74165	90p
74166	90p
74167	200p
74170	160p
74172	300p
74173	75p
74174	75p
74175	75p
74176	70p
74177	70p
74178	100p
74180	60p
74181	160p
74182	90p
74184A	120p
74185	120p
74186	500p
74188	325p
74190	75p
74191	75p
74192	75p
74193	75p
74194	75p
74195	60p
74196	70p
74197	70p
74198	120p
74199	120p
74221	75p
74251	70p
74259	120p
74278	150p
74279	80p
74283	75p
74284	250p
74285	250p
74290	100p
74293	100p
74298	100p
74365	55p
74366	55p
74367	55p
74368	55p
74390	100p
74393	100p
74490	120p

74LS SERIES

74LS00	12p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	16p
74LS08	16p
74LS09	20p
74LS10	15p
74LS11	15p
74LS12	20p
74LS13	25p
74LS14	45p
74LS15	30p
74LS20	15p
74LS21	15p
74LS27	20p
74LS30	17p
74LS32	20p
74LS33	20p
74LS37	20p
74LS38	20p
74LS42	45p
74LS47	45p
74LS51	20p
74LS55	30p
74LS73	25p
74LS74	20p
74LS75	28p
74LS76	30p
74LS83	50p
74LS85	70p
74LS86	24p
74LS90	35p
74LS92	40p
74LS93	35p
74LS96	110p
74LS107	45p
74LS109	60p
74LS112	40p
74LS113	45p
74LS114	45p
74LS122	42p
74LS123	55p
74LS124	120p
74LS125	30p
74LS126	30p
74LS132	45p
74LS133	30p
74LS136	30p
74LS138	36p
74S138	200p
74LS139	36p
74LS145	75p
74LS147	160p
74LS148	90p
74LS151	70p
74LS153	60p
74LS154	200p
74LS155	50p
74LS156	50p
74LS157	35p
74LS158	60p
74LS160	45p
74LS161	45p
74LS162	45p
74LS163	45p
74LS164	60p
74LS165	100p
74LS166	120p
74LS170	120p
74LS173	70p
74LS174	60p
74LS175	50p
74LS181	140p
74LS190	50p
74LS191	50p
74LS192	50p
74LS193	60p
74LS194	60p
74LS195	50p
74LS196	60p
74LS197	65p
74LS221	60p
74LS240	90p
74LS241	90p
74S241	400p
74LS242	80p
74LS243	80p
74LS244	80p
74LS245	90p
74LS247	70p
74LS248	90p
74LS249	90p
74LS251	50p
74LS253	40p
74LS257	45p
74LS258	45p
74LS259	90p
74LS266	25p
74LS273	90p
74LS279	45p
74LS283	45p
74LS298	160p
74LS299	40p
74LS323	250p
74LS324	150p
74LS348	200p
74LS352	100p
74LS353	100p
74LS365	36p
74LS367	36p
74LS368	36p
74LS373	80p
74LS374	80p
74LS375	50p
74LS377	90p
74LS378	70p
74LS390	60p
74LS393	60p
74LS399	200p
74LS445	140p
74LS540	135p
74LS541	135p
74LS640	300p
74LS641	300p
74LS642	300p
74LS643	300p
74LS644	300p
74LS668	100p
74LS669	100p
74LS670	170p

4000 CMOS

4000	14p
4001	16p
4002	15p
4006	65p
4007	18p
4008	60p
4009	40p
4010	40p
4011	14p
4012	20p
4013	35p
4014	60p
4015	60p
4016	30p
4017	45p
4018	60p
4019	32p
4020	60p
4021	65p
4022	70p
4023	24p
4024	40p
4025	20p
4026	130p
4027	32p
4028	60p
4029	75p
4030	40p
4031	170p
4033	180p
4034	160p
4035	80p
4036	295p
4037	115p
4038	120p
4039	295p
4040	55p
4041	70p
4042	55p
4043	60p
4044	70p
4045	120p
4046	70p
4047	75p
4048	55p
4049	27p
4050	27p
4051	60p
4052	80p
4053	60p
4054	130p
4055	125p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	18p
4069	20p
4070	20p
4071	20p
4072	20p
4073	20p
4075	20p
4076	60p
4077	25p
4081	20p
4082	20p
4086	72p
4089	150p
4093	40p
4094	150p
4095	95p
4096	95p
4097	340p
4098	90p
4099	120p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	45p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	70p
4503	50p
4507	40p
4508	200p
4510	65p
4511	50p
4512	65p
4514	150p
4515	150p
4516	75p
4518	45p
4520	70p
4521	150p
4526	75p
4527	90p
4528	75p
4532	90p
4534	500p
4536	300p
4538	120p
4543	100p
4553	290p
4555	60p
4556	60p
4560	180p
4566	180p
4569	180p
4572	30p
4583	90p
4584	45p
4585	100p
4724	150p
40014	90p
40085	120p
40097	90p
14411	700p
14412	900p
14433	1100p
14500	700p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

EXPERIMENTOR BREADBOARDS

EXP300	£5.75
EXP325	£1.60
EXP350	£3.15
EXP600	£6.25

HEADER PLUGS

14 pin	40p
16 pin	50p
24 pin	90p
40 pin	250p

DIL SWITCHES

4 way SPST	90p
6 way SPST	105p
8 way SPST	120p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-8910	700p
AY3-8912	650p
AY5-1224A	240p
AY5-1315	600p
AY5-4007D	520p
CA3019	80p
CA3046	70p
CA3038	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	300p
DAC1408-8	200p
HA1388	270p
ICL7106	850p
ICL8038	300p
LF13331	310p
LF351	48p
LF356P	95p
LM10C	425p
LM301A	27p
LM311	75p
LM318	200p
LM319	225p
LM324	45p
LM339	65p
LM348	75p
LM358P	75p
LM377	175p
LM380	75p
LM381AN	180p
LM386	95p
LM387	120p
LM389	95p
LM393	100p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	200p
LM3900	55p
LM3909	95p
LM3911	130p
LM3914	210p
LM3915	225p
LM3916	225p
LM13600	125p
MB3712	200p
MC1310P	150p
MC1458	40p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	90p
MK50398	750p
ML920	800p
MM57160	620p
NE531	150p
NE555	20p
NE556	60p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE571	425p
NE5534A	250p
RC4136	70p
RC4151	200p
S566B	260p
SAD1024A	1250p
SFF96364	800p
SL490	350p
SN76477	175p
SP8515	750p
TA7205	250p
TAA621	275p
TBA641B11	300p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA220	350p
TCA940	175p
TDA1004A	300p
TDA1008	320p
TDA1010	225p
TDA1022	600p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TLO71/81	45p
TLO72/82	75p
TLO74	130p
TLO84	110p
TLO94	200p
TL170	50p
UAA170	170p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	300p
XR2207	400p
XR2211	600p
XR2216	675p
ZN414	90p
ZN419C	225p
ZN424E	135p
ZN425E8	350p
ZN427E8	625p
ZN1034E	200p
ZN4256E8	350p

CPU's

1600	1200p
1802C	700p
2650A	1600p
6502	500p
6800	375p
6802	500p
6809	1600p
INS8060	1100p
8080A	450p
8085A	550p
8088	£25
Z80	400p
Z80A	550p

SUPPORT DEVICES

3242	800p
6522	500p
6532	800p
6821	180p
6850	180p
6852	250p
8205	320p
8212	180p
8216	180p
8224	250p
8228	250p
8251	400p
8253	800p
8255	400p
8257	800p
8259	800p
8279	950p
Z80P10	400p
Z80AP10	450p
Z80CTC	400p

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	400p
2112	300p
2114L	200p
2114L-2	300p
4027	375p
4116L-2	300p
4118	500p
5101L	350p
6116	1200p
6810	200p
8114	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

EPROMS

1702A	600p
2516(+5v)	400p
2708	400p
2716(+5v)	900p
2532(+5v)	900p

INTERFACE ICS

AD536A	1300p
AD558	775p
AD561J	1400p
DM8123	175p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	65p
MC1489	65p
MC3446	325p
25S10	350p
3242	800p
3245	450p
58174	1200p
75107	160p
75110	160p
75150	140p
75154	160p
75182	230p
75324	250p
75361	150p
75363	300p
75365	150p
75451/2	72p
75491/2	72p
8T26	120p
8T28	140p
8T95	140p
8T97	140p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	110p
9602	220p

UARTS

AY-3-1015D	400p
AY-5-1013A	350p
IM6402	450p
TMS6011NC	350p

CHARACTER GENERATOR

RO-3-2513U.C.	700p
RO-3-2513L.C.	700p
74S262AN	1000p

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	500p

CRT CONTROLLER

MC6845	1000p
MC6847	1000p
SFF96364	800p
TMS9918	6000p

MISC

6Mhz UHF MOD.	350p
8Mhz UHF MOD.	450p
Printer	6000p
S100 Busboard	1500p
DIN41612 Skt.	360p
DIN41612 Plug	250p
43 way Edge Con	250p
31 way Plug 0.1	120p
31 way Skt. 0.1	120p

Junior Computer Complete Kit **UK (inc. VAT and P&P) £100**
OVERSEAS (inc. P&P) £ 90
Serial I/P VDU Interface Kit (ELEKTERMINAL) **£56 plus VAT**

ACORN ATOM: This kit is supplied with full size QWERTY Keyboard, 8K ROM, 2K RAM and can be expanded on board to 12K ROM, 12K RAM. Also included are UHF Modulator for connection to domestic TV and Free Manual on Programming in BASIC and Machine Code. **KIT £120, BUILT £150**

SOFTY: Ideal Software/Hardware tool. You can develop your programmes, De-bug/Verify and then commit them to EPROM.
Ready built for programming +5V Eproms **£170**

Programmed 82S23 for junior computer
(ELEKTOR May '81) **£350**

MINI FLOPPY DISC DRIVE: Teac FD-50A 40 track 5¼" Double/-Single Density Drive **£140**

FLOPPY DISC CONTROLLER: FD 1771 **£24** FD 1791 **£36**

PCBs FOR MOST ELEKTOR PROJECTS AVAILABLE

Programmed 2708 for Disco Lights (Elektor Jan. 81) **£8**
Programmed 2716 for Intelekt (chess) (Elektor April.81) **£10ea.**

COUNTERS

74C925	550p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	700p

TTL & ECL

MC4024	325p
4044	325p
10116	70p
10231	350p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	50p	7905	55p
6v	7806	50p	7906	70p
8v	7808	55p	7908	70p
12v	7812	50p	7912	55p
15v	7815	55p	7915	60p
18v	7818	55p	7918	60p
24v	7824	55p	7924	60p

100mA	+ve		TO-92	
5v	78L05	30p	79L05	60p
12v	78L12	30p	79L12	60p
15v 78L15		30p	79L15	60p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	500p	79GUIC	225p
LM723	37p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MSC2400	190p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL212 Ye	25p	TIL228 Ye	22p
TIL211 Gr	20p	Rectangular	
TIL216 Red	18p	LEDS (R, G, Y)	30p

DISPLAYS

3015F	200p		
DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	120p	**DRIVERS**	
FND507	120p	9368	250p
MAN3640	175p	9370	300p
MAN4640	200p	UDN6118	320p
MAN6610	300p	UDN6184	320p

TRANSISTORS

BC107/8	11p	MJ2955	90p
BC109/C	12p	MJ3001	225p
BC140	40p	MJE2955	130p
BC141	40p	MJE3055	100p
BC160	40p	MPF102	40p
BC161	40p	MPF103/4	35p
BC177	18p	MPF105	35p
BC178/9	20p	MPSA12	50p
BC182/L	9p	TIP29A/C	45p
BC183/L	9p	TIP30A/C	50p
BC184/L	9p	TIP31A/C	60p
BC212/L	9p	TIP32A/C	75p
BC213/L	9p	TIP35C	290p
BC214/L	9p	TIP36C	340p
BC327	16p	TIP41A/C	72p
BC337	16p	TIP42A/C	80p
BC338	16p	TIP2955	90p
BC477	30p	TIP3055	70p
BC516/7	40p	2N918	45p
BC547B	16p	2N2160	350p
BC548B	12p	2N2219A	30p
BC549C	18p	2N2222A	30p
BC557B	16p	2N2646	45p
BC558B	12p	2N2905A	30p
BC559C	18p	2N3053	30p
BCY70	18p	2N3054	65p
BCY71/2	22p	2N3055	50p
BD131/2	50p	2N3442	140p
BD135/6	50p	2N3702/3	12p
BD139	50p	2N3704/5	12p
BD140	50p	2N3773	300p
BD241B	70p	2N3819	22p
BD242B	70p	2N3820	40p
BF244B	40p	2N3866	100p
BF256B	70p	2N3904/6	18p
BF257/8	36p	2N4871	60p
BF259	40p	2N5245	40p
BF337	30p	2N5457/8	40p
BFT66	200p	2N5459	40p
BFY50/1	30p	2N6027	48p
BFY52	30p	3N128	120p
BFY90	90p	3N140/1	120p
E420	300p	40673	85p
MJ2501	225p	40871/2	100p

DIGITAST SWITCHES

Any colour	60p
With LED	90p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	22p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

EDGE CONNECTORS 0.156"

2 × 10	85p	2 × 15	100p
2 × 18	120p	2 × 22	135p
2 × 25	160p		

DIODES

BY127	12p
OA47	9p
OA91	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	6p
IN4006/7	7p
IN5401/3	14p
IN5404/7	18p
IS920	9p

BRIDGES

1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A450V	100p
6A50V	80p
6A100V	100p
6A400V	120p
10A100V	200p

ZENERS

2.7V-33V	
400MW	9p
1W	15p

TRIACS

Plastic

3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ANTEX SOLDERING IRONS

C 15	£4.00	Spare Bits	50p
CCN 15	£4.20	Spare Elements	£2.00
CX 17	£4.20	Stand ST3	£1.60
X25	£4.20		
Solder Sucker	Major £7.50	Minor	£6.00

★ SPECIAL OFFER ★

2114L–4	£1.20
2708	£3.00
2716(+5V)	£2.75
4116L–2	£1.10

(Offer subject to stocks)

LOGIC PROBES		IC TEST CLIP	
LP1	£31	16 Pin	£2.75
LP2	£18	24 Pin	£4.90
LP3	£49	40 Pin	£7.90

CRYSTALS

100KHz	300p
200KHz	300p
1MHz	300p
1.008MHz	370p
1.843MHz	250p
2.0MHz	250p
2.457MHz	250p
3.276MHz	250p
3.57945MHz	200p
4.0MHz	250p
4.19MHz	250p
4.43MHz	250p
6.0MHz	250p
7.0MHz	250p
8.0MHz	250p
8.867MHz	350p
10.7MHz	250p
15.0MHz	350p
18MHz	275p
26.690MHz	210p
27.145MHz	210p

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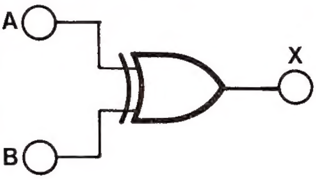
lektor Infocard 30 | Standards 7 | EXCLUSIVE-OR gates truth tables

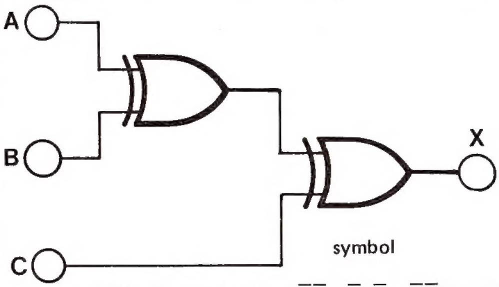


symbol

logic: $X = A \oplus B = A\bar{B} + \bar{A}B$

A	B	X
L	L	L
H	L	H
L	H	H
H	H	L

truth table



symbol

logic: $X = A \oplus B \oplus C = A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}C + ABC$

A	B	C	X
L	L	L	L
H	L	L	H
L	H	L	H
H	H	L	L
L	L	H	H
H	L	H	L
L	H	H	L
H	H	H	H

truth table

L = low
H = high

---

lektor Infocard 31 | discrete components 2 | general information on capacitors

lid capacitor types:
- plastic capacitors
- ceramic capacitors
- mica capacitors
- paper capacitors
- electrolytic capacitors

The metallized films are either wound constructions in tubular or flattened form or arranged in the more recent stacked construction. The metal spray method used for joining the winding face ends ensures that all the windings are connected. Hence, the capacitors feature low inductance and low loss characteristics.

etal-plated plastic capacitors (such as
K capacitors, for instance) are able to
store themselves when a breakdown has
ccurred. A very thin layer of metal is
eposited on the plastic foil. This is
02 . . . 0.05 μm thick. The arc
used during a breakdown evaporates
e metal layer in its immediate vicinity
ithout damaging the dielectric. This
appens in less than 10 μs. The loss in
pacitance is negligible.

DIN code:
M = metal-plated
K = plastic

the third letter represents the fifth letter in the name of the dielectric.

S =	polystyrene	(MKS ≡ MKY)
P =	polypropylene	(MKP)
C =	polycarbonate	(MKC ≡ MKM)
T =	polythereftalate	(MKT ≡ MKH)
U =	cellulose acetate	(MKU ≡ MKL)

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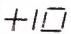
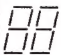
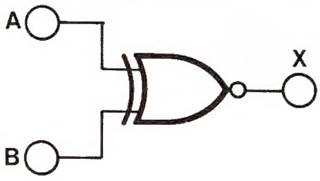
lektor Infocard 32 | discrete components 8 | pin assignments for seven-segment LED displays

pe	colour code				code for common		digit height			decimal point		case
	red	yellow	green	orange	anode	cathode				left	right	
X . . .	86 .	92 .	90 .	88 .	. . A	. . K	13	X	X	–	X	16
X . . .	87 .	93 .	91 .	89 .	. . A	. . K	13	–	X	–	X	17
214 . .	. . . . r	–	–	 0	. . . 2 .	. . . 4 .	14	–	X	–	X	18
214 . .	. . . . r	–	–	 0	. . . 3 .	. . . 7 .	14	X	–	–	X	19
AN	67 . .	–	–	66 . .	. . 10	. . 40	14	–	X	–	X	17
AN	67 . .	–	–	66 . .	. . 30	. . 50	14	X	–	–	X	20

elektor infocard 30 | Standards 7 | EXCLUSIVE-NOR gates truth tables

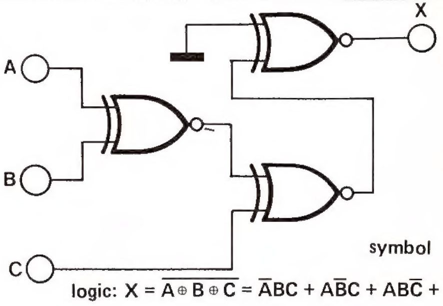


symbol

logic: $X = \overline{A \oplus B} = AB + \overline{A}\,\overline{B}$

A	B	X
L	L	H
H	L	L
L	H	L
H	H	H

truth table



symbol

logic: $X = \overline{A \oplus B \oplus C} = \overline{A}BC + A\overline{B}C + AB\overline{C} + \overline{A}$

A	B	C	X
L	L	L	H
H	L	L	L
L	H	L	L
H	H	L	H
L	L	H	L
H	L	H	H
L	H	H	H
H	H	H	L

truth table

L = low
H = high

---

elektor infocard 31 | discrete components 2 | general informati on capacitors

Polystyrene and polypropylene capacitors are suitable for use in tuned circuits, filters and in applications where stability and low loss are prerequisites.
Polyester and polycarbonate capacitors are mostly used to couple and decouple voltages and in timing, delay systems, etc.
MKS and MKP types.
Ceramic capacitors, where the dielectric consists of a ceramic material, are made with a very wide range of temperature coefficients, extending from +100 ppm/K to −5600 ppm/K. Depending on which type is used, the temperature coefficient will either be independent of the temperature or will vary in proportion to it. The latter type is highly suitable for compensating the temperature dependence of certain components, such as ferrite coils which have a positive temperature coefficient. When using ceramic feed-through capacitors, care must be taken to avoid excessive mechanical stress as this might cause the ceramic to break.
Electrolytic capacitors where the dielectric is obtained by means of electrolysis fall into two categories: aluminium and tantalum types. In both cases the polarity mus be observed. Generally speaking, tantalum electrolytic capacitors feature lower leakage currents and a longer lifespan than their aluminium counterparts.

N.B. All types of capacitors have maximum AC voltage and current limits.

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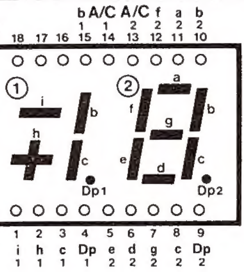
elektor Infocard 32 | discrete components 8 | Pin Assignments fo Seven-segment LED Displays

16)



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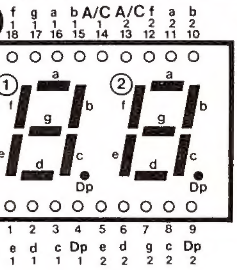

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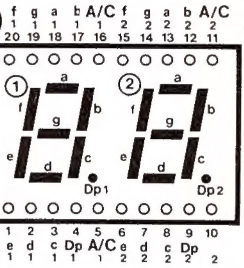

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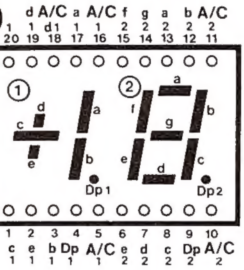

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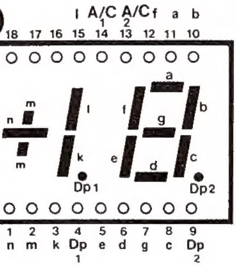

contents

lektor 11-01

etal detector 11-04
ie metal detector featured in this article is very professional in appear-
ce and operation and performs better than many high-priced commercial
tectors. It is both highly stable and sensitive. The construction is very
nple since all the obstacles usually associated with this type of project
ve been removed.

gh boost 11-12
.M. Bosschaert)
ie average tone control circuit in an electric guitar usually consists of
tle more than a capacitor and a potentiometer and can hardly be ex-
cted to produce very good results. An active tone control is much more
ective and this high boost circuit can either amplify or attenuate the
ble within a range of 35 dB.

w synthesiser 11-14
e success of the Elektor Formant synthesiser led us to the opinion that
ere is a great interest among our readers in the field of electronic musical
truments, especially synthesisers. The new Elektor synthesiser is of
dular construction and can be expanded into a polyphonic instrument
th 'programming' facilities. This, the first article in the series, explains
basics behind the design.

CD frequency counter 11-18
is is the first in a series of projects featuring a frequency counter mod-
with a liquid crystal display. The high performance is out of all pro-
rtion to the simplicity of the circuit. Two switched ranges are available,
first up to 4 MHz for use in monitoring frequencies in microcomputers
d the second up to a maximum of 35 MHz to cover CB transceivers and
ieral use.

lescope control 11-21
camera mounted on a telescope can, with a long enough time exposure,
able the more distant stars to be observed. The circuit in this article
ables the telescope to track the star accurately for the period of the
posure.

lar powered receiver 11-23
e design described in this article is a low cost portable receiver that can
powered with surprisingly few solar cells.

ini organ 11-26
anks to ITT's special organ IC the electronics for the mini organ can
ily be built in an afternoon. It uses a full size keyboard and is poly-
onic. Its performance is so good that it really must be seen to be be-
ved.

ephone amplifier 11-32
pound for a minute seems a lot of money to hear Granny's faint voice
thousand miles away and then not understand a word she's saying.
is telephone amplifier provides a solution and enables the whole family
listen in to the conversation.

ie-wave oscillator 11-34
Boullart)
is particular design is not at all complicated as far as construction is
ncerned and yet it boasts a distortion level of only 0.01%! Its fre-
ency range extends from 10 Hz up to an inaudible 100 kHz.

letext decoder part two 11-38
is article deals with the practical side of the Teletext decoder. Particular
ention is paid to the modification of a TV set if the decoder is to be
ilt in; calibration procedures; and, last but not least, the instructions
use.

eak to your computer 11-45
e removal of the key pad interface between man and computer has long
en the pipedream of every programmer. When using the M 6800 system
can become reality.

arket 11-49

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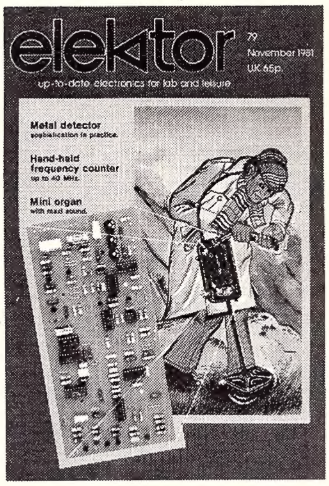
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Example:

digisplay	**(E13)**	**9376**	**3.25**	**7.25**
1	**2**	**3**	**4**	**5**

1. Circuit title
2. reference to associated article(s)
3. board number
U.K.:
4. price (in £) inclusive of 15% VAT
U.S.A. and Canada:
5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
formant (E25 . . . E30):			
VCO	9723-1	9.90	23.50
experimenting with the SC/MP:			
RAM-I/O	9846-1	6.90	16.50
SC/MP board	9846-2	2.60	6.—
E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32):			
ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31,E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	4.35	10.50
experimenting with the SC/MP (E31 . . . E33):			
HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
4 k RAM card	9885	14.70	35.—
SC/MP power supply	9906	4.05	9.50
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
cassette interface	9905	3.—	7.—
E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
touch dimmer	78065	1.30	3.—
consonant	9945	8.40	20.—
preconsonant	9954	2.25	5.50
E41: SEPTEMBER 1978			
formant			
24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
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VHF/UHF modulator	9967	1.55	4.—
E43: NOVEMBER 1978			
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E44: DECEMBER 1978			
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timebase board	9969-3	1.95	4.50
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E46: FEBRUARY 1979			
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pools predictor	79053	2.25	5.50
E47: MARCH 1979			
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E48: APRIL 1979			
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E49: MAY 1979			
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E50: JUNE 1979			
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E51/52: JULY/AUGUST 1979			
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E53: SEPTEMBER 1979			
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E54: OCTOBER 1979			
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E55: NOVEMBER 1979			
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E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
electronic nuisance	80016	1.50	3.50
steam train	80019	1.90	4.50
toppreamp	80031	3.95	9.50
E57: JANUARY 1980			
VSWR meter	79513	2.05	5.—
digital tuning scale (two boards)	80021-1/2	7.05	17.—
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colour generator	80027	2.75	6.50
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E58: FEBRUARY 1980			
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elektor vocoder,			
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E59: MARCH 1980			
slide faders:			
mains-powered version	9955	1.40	3.50
chorosynth	80060	22.15	53.—
printer for µPs	80066	5.80	14.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.5
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E61: MAY 1980			
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Junior computer:			
main board	80089-1	12.60	30.—
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supply board	80089-3	3.—	7.—
EPROM alternative	80112-1	1.55	3.5
slow memory access	80112-2	1.20	3.—
E62: JUNE 1980			
morse trainer	80072	6.—	14.5
Ω aerial:			
supply board	80076-1	1.80	4.5
amplifier	80076-2	1.60	4.—
luxury transistor tester	80077	3.60	8.5
pest pester	80130	1.10	2.5
E63/64: SUMMER CIRCUITS 1980			
shop window lighting (two boards)	80515	4.10	9.5
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E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.5
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VOX	80138	2.40	5.5
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E66: OCTOBER 1980			
LCD frequency counter	80117	2.55	6.—
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programmable slide fader	81002	7.40	17.5
touch doorbell	81005	1.45	3.5
E67: NOVEMBER 1980			
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fridge alarm	81024	1.45	3.5
draught detector	81028	1.45	3.5
simple fuel consumption meter			
module 1	81035-1	1.65	4.—
module 2	81035-2	1.40	3.5
module 3	81035-3	1.40	3.5
main/display board	81035-4	2.50	6.—
E68: DECEMBER 1980			
genie in a can	81042	1.55	3.50
canometer:			
main board	81043-1	1.85	4.50
display board	81043-2	1.30	3.—
multican	81044	3.05	7.50
bath thermometer	81047	2.15	5.—
piping can	81048	2.—	5.—
NiCad piggy bank	81049	2.20	5.—
xylophone	81051	1.70	4.—
E69: JANUARY 1981			
disco ceiling lights	81012	8.70	20.50
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swinging poster board	81073	3.05	7.50
raw power	81082	3.05	7.50
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low voltage board	81085-1	2.30	5.50
main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
150 W converter	81001	5.30	12.50

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ntrol board	81105-2	2.05	5.—

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sistor match-maker	81123	1.75	4.—
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E73: MAY 1981

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E74: JUNE 1981

map reader	81032	1.40	3.50
Junior Computer			
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E75/76: SUMMER CIRCUITS 1981

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E77: SEPTEMBER 1981

TV games computer extension board	81143	19.—	45.—
disco light controller	81155	3.20	7.50
DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
digital barometer	81173	3.50	8.50

E78: OCTOBER 1981

RF-test generator	81150	1.60	3.80
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shutter speed meter	82005	3.75	9.00
LCD panel meter	82011	1.65	4.00
universal LED display	82015	1.60	4.00

NEW

E79: NOVEMBER 1981

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decoder board	82001-2	5.35	12.50
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ps front panels

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rface	9721-F	1.60	4.—
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B VCF (E41)	9953-F	1.60	4.—
nance filter odule (E42)	9951-F	1.60	4.—
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ope, basic version	9968-F	1.45	3.50
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transfers

transfers

E63/64, E65			
musical box ulp amp STAMP amplifier small μp switching supply stereo dynamic preamplifier	t-001	£ 1.—	$ 2.—
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ing SC/MP: well- wn Christmas odies, both as MP program and '	ESS 002	1.40	3.50
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EDITOR
P. Holmes

U.K. EDITORIAL STAFF
T. Day E. Rogans
P. Williams

TECHNICAL EDITORIAL STAFF
J. Barendrecht
G.H.K. Dam
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Technical telephone query service, Mondays only, 13.30 - 16.15, tel.: 0227-53474.

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ABC

decoder

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for µA741, LM741, MC1741, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

$U_{CEO, max}$	20V
$I_{C, max}$	100 mA
$h_{fe, min}$	100
$P_{tot, max}$	100 mW
$f_{T, min}$	100 MHz

Some **'TUN's** are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP's** are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
$U_{R, max}$	25V	20V
$I_{F, max}$	100mA	35mA
$I_{R, max}$	1µA	100 µA
$P_{tot, max}$	250mW	250mW
$C_{D, max}$	5pF	10pF

Some **'DUS'** are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG'**s are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:

p	(pico-)	= 10^{-12}
n	(nano-)	= 10^{-9}
µ	(micro-)	= 10^{-6}
m	(milli-)	= 10^{-3}
k	(kilo-)	= 10^{3}
M	(mega-)	= 10^{6}
G	(giga-)	= 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF
0.000 000 000 004 7 F . . .
Capacitance value 10n: this is
international way of writing 10,000 pF or .01 µF, since 1 n
10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbo
types, unless otherwise specifie
The DC working voltage of capacitors (other than electrolytics) is normally assumed to
at least 60 V. As a rule of thun
a safe value is usually approximately twice the DC supply voltage.

Test voltages
The DC test voltages shown ar
measured with a 20 kΩ/V inst
ment, unless otherwise specifie

U, not V
The international letter symbo
'U' for voltage is often used instead of the ambiguous 'V'.
'V' is normally reserved for 'vol
For instance: U_b = 10 V,
not V_b = 10 V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It
assumed that our readers know what voltage is standard in the
part of the world!
Readers in countries that use 60 Hz should note that Elekto
circuits are designed for 50 Hz operation. This will not norma
be a problem; however, in case
where the mains frequency is
for synchronisation some mod
cation may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a
printed circuit board. Some — not all — of these boards are a
able ready-etched and predrille
The 'EPS print service list' in t
current issue always gives a co
plete list of available boards.
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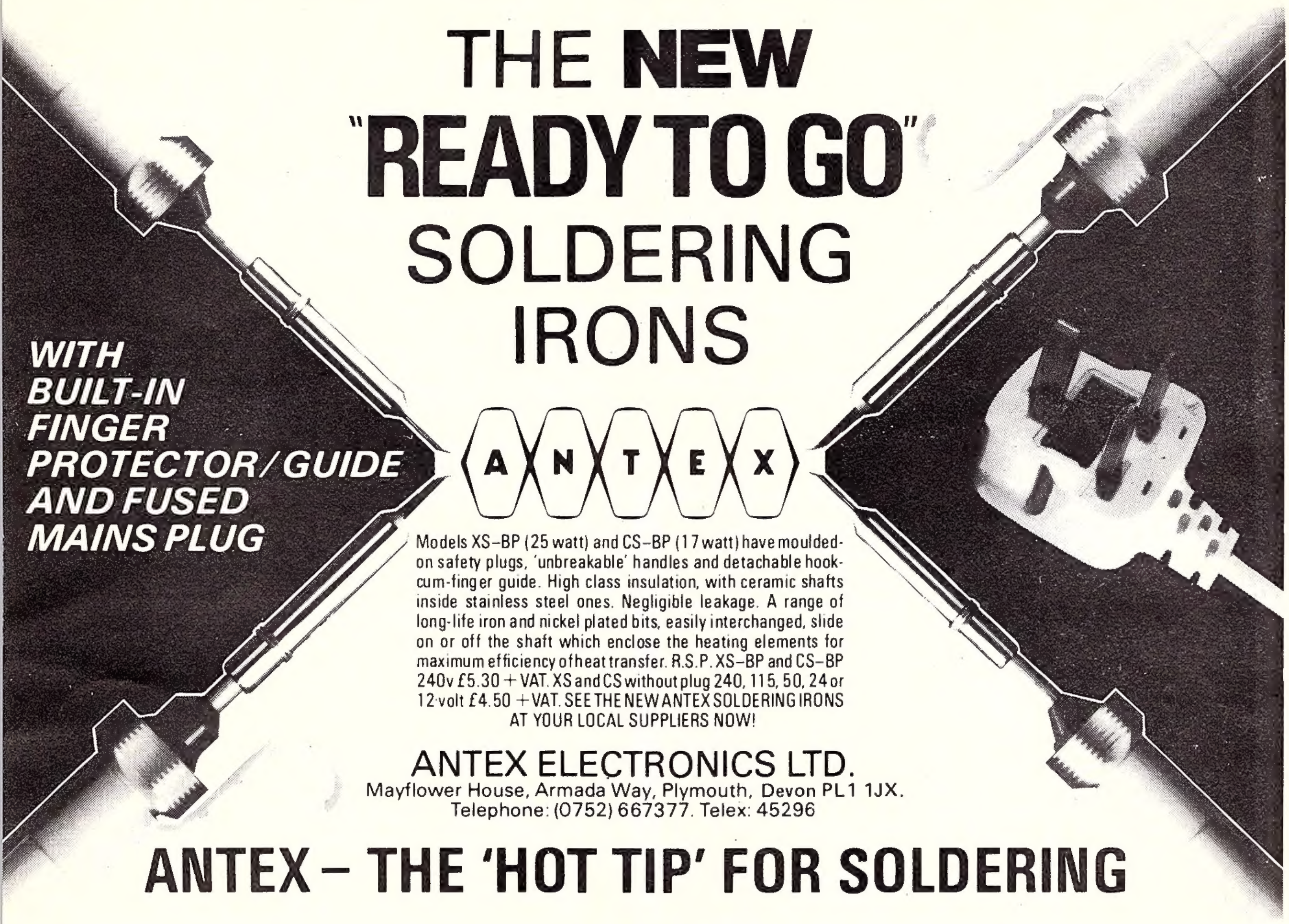

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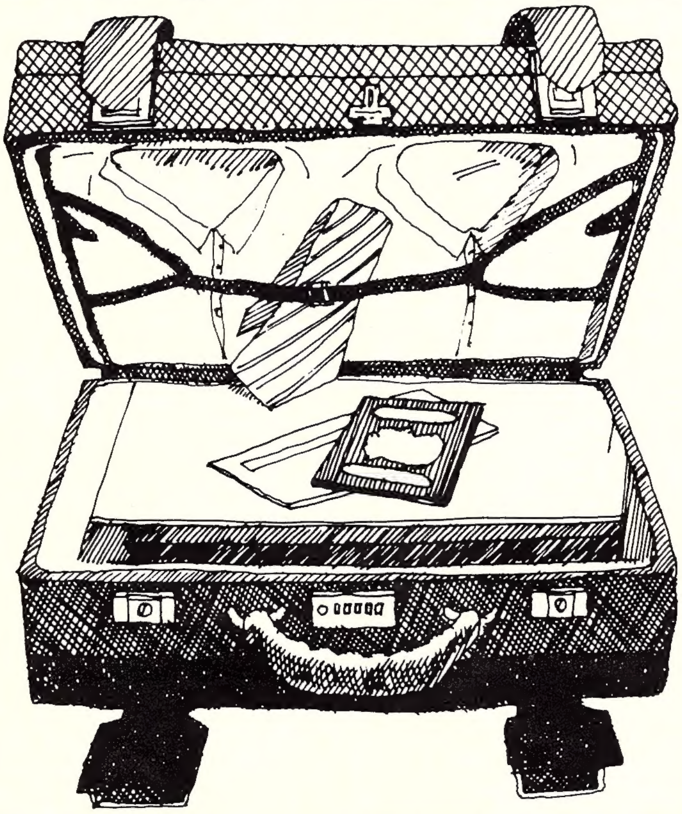

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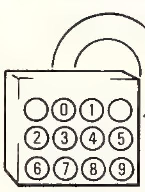

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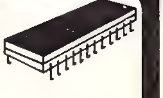

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CT5000K Timer Kit (includes all components, assembly and programming instructions and an attractive black case)

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MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

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REMOTE CONTROL COMPONENTS AND KITS

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SL490 32-command encoder/ transmitter	2.40	Clip on Plastic reflector for IR LEDs, increases range.	.20
ML922 10-channel receiver + 3 analogue outputs	4.20		
ML926 16-channel receiver 4 momentary binary outputs	1.40		

ML925. A decoder designed for model/toy control, providing a 2 speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc Outputs also available for other facilities such as horn, turn indicators, headlights, etc.	2.10

KITS ++++ KITS ++++ KITS ++++ KITS ++++ KITS

MK6– Simple Infra Red TRANSMITTER. A pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery	4.20
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MK9– 4-Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter.	1.90
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MK11– 10 On/Off Channel IR RECEIVER with 3 analogue outputs (0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be be used for sound muting Based on ML922 decoder IC. Includes its own mains supply.	12.00
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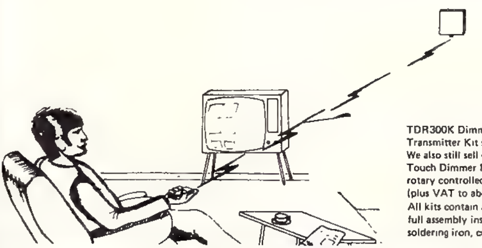

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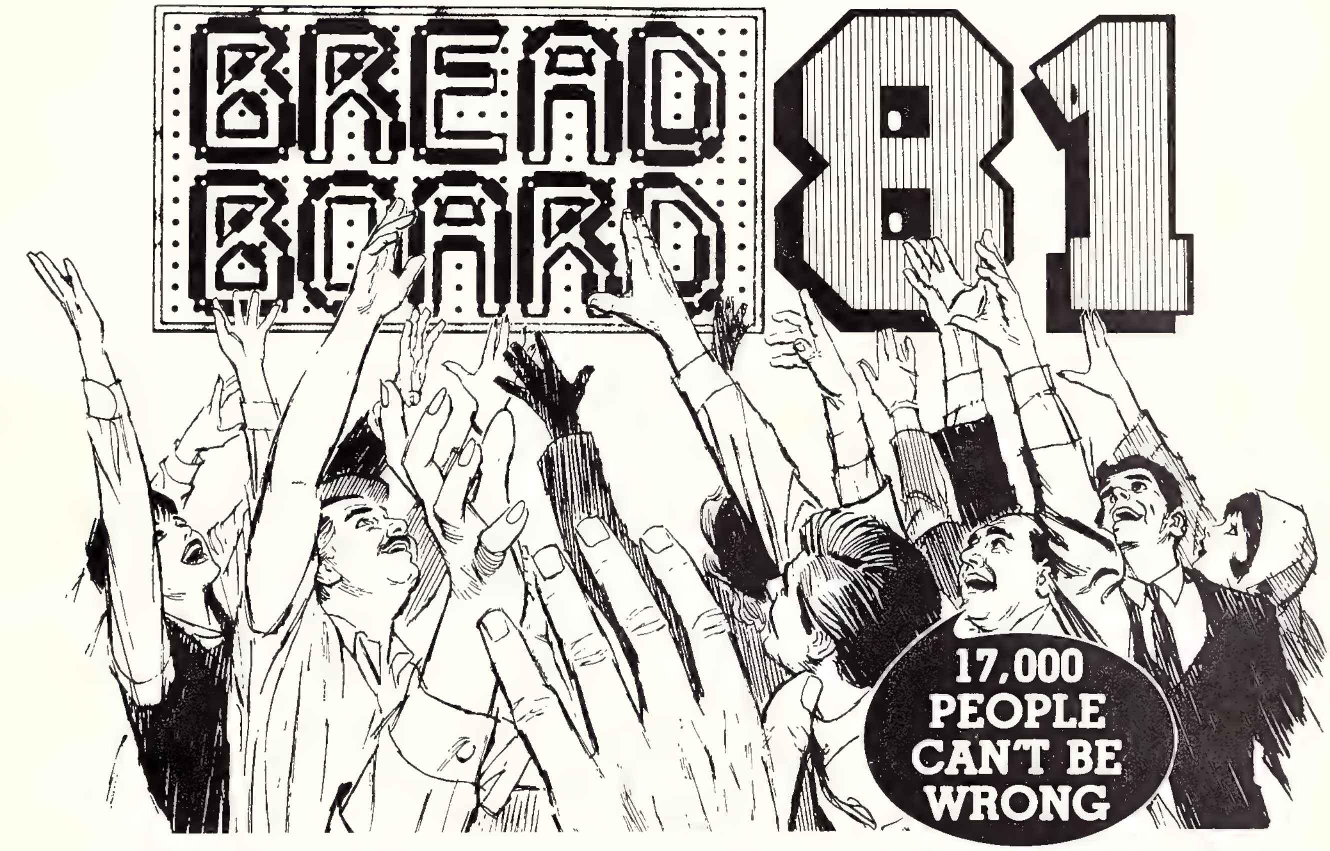

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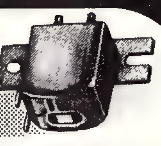

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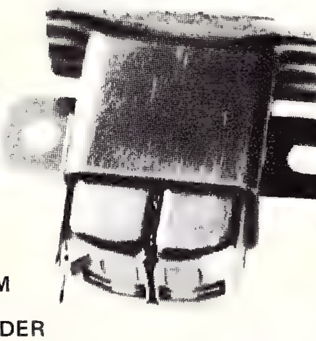

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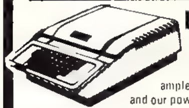

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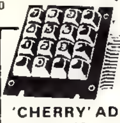

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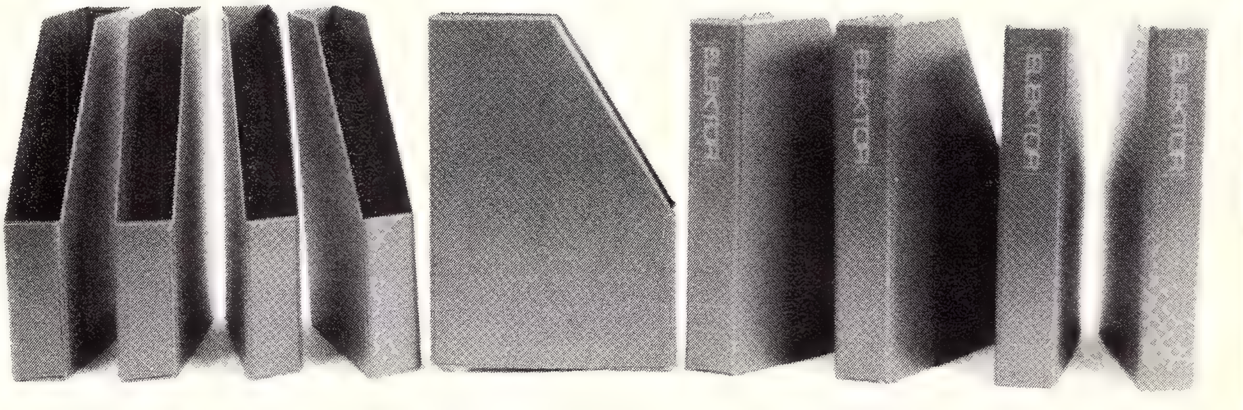


selektor

he electromagnetic spectrum risis

Ve have only to listen in on the broadasting bands at night to notice how ome stations appear to be jumbled up n top of one another. Though local nes can be received quite well, there is onsiderable interference on the distant ansmissions, for the region of the lectromagnetic spectrum devoted to adio, necessarily very small, is every ay becoming more congested. It is, herefore, a finite resource, upon which ver growing demands are made. This roblem could be called the electroagnetic spectrum crisis, and in some ays it is more acute than the so-called nergy and materials crises which have eceived so much attention.

o explain the difficulty that the develped world is certain to have to face ver the radio spectrum, it is necessary o explain the scientific background. To adiate or receive a radio wave it is ecessary to use some kind of aerial ructure, or antenna. This structure is ecessarily related to the length of the ectromagnetic waves: ideally its size hould be at least a substantial fraction f the wavelength. If it has to be made naller, efficiency declines rapidly, and ven a powerful transmitter connected it would produce only a feeble radio gnal.

he wavelength is given by dividing the elocity of light by the number of times at the transmitted wave oscillates in second, that is, its frequency. The elocity of light is approximately x 10^8 metres per second, so a wave ith a frequency of 10 000 cycles per cond (hertz) has a length of about 0 km. Obviously, an aerial comparable size with this would be very unwieldy nd suitable only for a very large land stallation. Because of this, frequencies elow 10 Hz are of little practical use r radio purposes; it is a limit set by a hysical law which is likely never to be rcumvented.

he upper limit is just as rigid. The ain attraction of radio waves for mmunication is their great penetratg power. They are little absorbed by e atmosphere, so are able to propagate ver long distances with only a small ss. Unfortunately this ceases to be ue for frequencies of the order of 0 000 million hertz and above. At such equencies absorption of radio energy the atmosphere is already considerble and it rises rapidly at higher equencies.

o we are trapped, for most comunication purposes, in this radio 'window'. Obviously, the usable radio spectrum is a natural resource of quite fixed extent. That is one side of the spectrum congestion problem; the other is the width in the electromagnetic spectrum taken up by each radio transmission.

Modulation

All radio transmitters use a technique known as modulation to impress the intelligence to be transmitted on to the radio wave. An unmodulated radio wave simply consists of an oscillation at a particular radio frequency. The only information that it conveys is the fact that it is present. To communicate we must cause it to vary in some way. The simplest thing that we could do would be to keep turning it on and off in the familiar Morse code, the way the earliest transmitters were used for telegraphy. Usually, however, we wish to transmit the human voice or other complex signals, and to do this we must alter the radio wave in accordance with the characteristics of the signal waveform that we wish to convey.

Most existing radio transmitters modulate the carrier wave in one of two ways. They either vary its amplitude in sympathy with the modulating signal, a process called amplitude modulation (AM), or they vary the frequency of the wave, a technique known as frequency modulation (FM).

Although the carrier wave was initially on a fixed, single frequency, as soon as it is modulated energy begins to be radiated at other, additional frequencies. What happens is that two new sources of radio energy appear, called sidebands, which are seen above and below the carrier frequency and each separated from it by an amount just equal to the modulating frequency. For AM the width of the transmission in the spectrum (we call it the bandwidth) is just equal to twice the modulating frequency. Radio frequency allocation is based on each transmitter radiating in an assigned channel which in practice should be a little wider than its bandwidth.

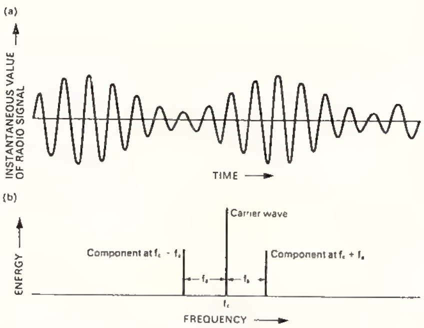


Figure 1. The amplitude of a modulated carrier wave (a) varies at a rate corresponding to the frequency of the modulating signal it carries. This complex wave is the sum of the original carrier wave, shown in (b) with frequency f_c, and two side components at frequencies equal to the sum and difference of the carrier frequency and the modulating frequency, f_a. When the modulating wave itself is complex, as in speech for example, the side components spread out over bands of frequencies on each side of the carrier, each band corresponding to the band of modulating frequencies. They are known as the upper and lower sidebands.

Spurious Emission

Theoretically, an AM transmitter should radiate nothing else but the carrier and the two sidebands and therefore have a spectrum entirely contained within a bandwidth equal to twice the highest modulation frequency. But in practice AM transmitters are not quite perfect and therefore do radiate some additional energy, which we call spurious emission, generally at other frequencies further removed from the carrier frequency.

In the case of frequency modulation, the effect is to crowd up some of the waves in time and spread others out, but the intensity of the wave remains constant. But the FM wave has a much more complicated spectrum than the AM wave and there are, in theory, an infinite number of separate spectrum lines corresponding to individual frequencies at which energy is radiated.

In this case we might be forgiven for supposing that the bandwidth of an FM wave is infinite. Strictly speaking that is true, but the energy contained in each of the very large number of sidebands from the FM transmission decreases very rapidly with increasing difference in frequency from the carrier, so we can regard the bandwidth as being finite for practical purposes. The mathematics needed to calculate the bandwidth of an FM transmission is complicated and depends in particular on how much the frequency is shifted by the modulation; the shift is called the frequency deviation. Here, too, the total bandwidth occupied can be shown to be a factor multiplied by the modulating frequency, but that factor has a value always greater than two, which it would have been for AM. So FM always has a wider bandwidth than AM.

Television

As far as the modulating frequency is concerned, in the case of human speech it is not necessary to transmit signal frequencies above 3 or 4 kHz, depending on the quality of voice that is required, but for music a good quality transmission should extend to perhaps

selektor

selektor

15 kHz of modulating frequency. With AM the minimum bandwidth for a voice transmission might be 6 or 8 kHz and for a high quality music channel at least 30 kHz. Using FM these bandwidths are substantially greater; for example, the present BBC VHF/FM transmissions have a bandwidth of some 200 kHz. Some kinds of signals even demand very much greater bandwidth than this, and the greatest sinner of all is television.

Transmitting a good quality television signal can mean using a signal frequency of up to 4000 or 5000 kHz, depending on the technical details, and for this reason a relatively wide channel is taken up. In open broadcasting FM is never adopted for television; even AM, used in the earliest television broadcasts, gives a transmission of great width in the spectrum. So television is nowadays transmitted on a modified form of AM.

There is an element of redundancy in both the AM and FM transmissions, for they are symmetrical about the carrier frequency and therefore the essential information conveyed by the modulation is represented twice, once above the carrier and once below. This led to the evolution of two closely related alternative forms of modulation, known as single sideband (SSB) and vestigial sideband (VSB). Both are derived from AM. In SSB the carrier and one of the sidebands generated by the amplitude modulation process are totally suppressed and only the other sideband is transmitted. Provided a carrier wave of the correct frequency can be generated at the receiver, all the information needed to reconstruct the original modulated signal is still present in the transmission, because the magnitude of the signal is represented by the sideband amplitude and its original frequency by the difference between the sideband and carrier frequencies. In theory, single sideband transmissions occupy only half the bandwidth of full AM transmissions without the loss of any information.

Vestigial Sideband

SSB is now extensively used in military and commercial point-to-point and mobile radio systems. But for television the alternative, vestigial sideband system (VSB) is preferred, in which the carrier and one complete sideband are left in the transmission but the width of the other sideband is restricted to accommodate only the lower modulating frequencies. This is marginally less economical in terms of bandwidth, but makes for cheaper design of transmitters and receivers. Obviously, for mass-produced television sets this is a considerable advantage and the small bandwidth penalty is not significant. Using techniques of this kind it is possible to transmit a satisfactory television signal in 6000 kHz or so, but it is still worth remarking that we could have a thousand speech channels for every television channel.

In addition to broadcasting, the radio spectrum is used for radiotelephones, for mobile communications with aircraft, ships and vehicles, for point-to-point transmissions within countries and on the transcontinental scale, too, and for services such as radar and radio navigation which play a vital role in our modern society. Given that the resource is finite, it is clear that there is a limit to the number of users who can simultaneously exploit the economic advantages or radio systems.

Does this matter? After all, the world existed for a long time without radio. Will it be a very serious disadvantage if the growth of radio is shackled by spectrum congestion? It is obvious that although there are some areas where the use of radio might be described as a luxury, there are others where its application is absolutely unavoidable. For example, it is very difficult indeed to imagine airlines running without radio communication, and the policing of our cities could hardly continue if the use of radio were denied. In fact, a feature of the economic development of the whole western world in recent years has been the growing use of radio. All the parameters of economic growth in our society correlate very closely with that growth, and it is difficult to foresee that our economy could continue to develop
if the expansion of radio stopped.
particular, if we face an era in whi
energy costs are going to rise, the use
vehicles will have to be more efficier
and mobile radio is the most importa
resource for making this possible.

London's police force is little strong
in numbers than it was in the 1920s,
spite of an enormous growth in pop
lation with a corresponding increa
in crime and in road users. Senior poli
officers have no doubt that the abili
to go on policing the region effective
depends mainly on the use of radio
cars and of personal radios by individu
officers.

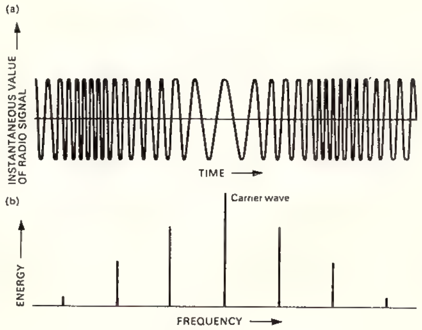


Figure 2. In frequency modulation, the frequency of the carrier wave is varied to impress the modulating intelligence on it, while the amplitude is kept constant. An analysis of the complex modulated wave shows, in theory, an infinite number of separate spectrum lines in addition to the carrier, corresponding to individual frequencies at which energy is radiated. However, the energy they contain falls off fairly rapidly on either side with the increasing separation from the carrier.

Transport

Where public radio paging and c
telephone services are available, they a
showing steady rates of growth, whi
means people must think the cost
justified, while private mobile radio
playing a vital part for many compani
in enabling them to run their busine
more efficiently. Studies have show
for example, that commercial delive
services can make savings of sor
20 per cent in fuel and in use of vehic
by introducing radio. Taxis are nc
largely dependent on it, the growi
number of ships in the world a
entirely dependent on it and new che
air fares may be expected to accelera
the already rapid growth of air trav
and thereby complicate problems
radio-dependent air traffic contr
Already it has been necessary to hal
the width of aircraft radio channels
ease congestion.

Then there are areas where the use
radio is just beginning: the UK Trar
port and Road Research Laboratory h
shown that radio can reduce the costs
town and country bus services by 20 p
cent and reduce passenger waiting tir
at stops by 16 per cent.

Safety of life

It is difficult to quantify the econom
advantages of any one of these app
cations; emergency life-saving rad
services cannot be costed at all. A
there is the social value to consider, f
good or ill, of radio and televisi
broadcasting. Clearly the public at lar
puts a high value on such services.

Inevitably, we must conclude that it
a matter of the utmost importance, f
both economic and social reasons,
provide radio services as freely as pc
sible to those who can make good u
of them. So we are faced with a ve

ficult problem of spectrum manage-
nt. What are the rules for making
: best use of our electromagnetic
ritage? I believe that they fall into
o categories, avoidance of pollution
d right organization of use.

are all familiar with the irritating
erference created by electrical
chinery. Everybody knows that a
od deal can be done to reduce this
isance by treating the offending
uipment and nowadays there are
te stringent laws in many countries
out fitting interference suppressors.

worse pollution hazard probably
nes from communications equipment
elf, which is capable of interfering
h other users and cannot be sup-
essed easily, for by its very nature a
lio transmitter must be able to
liate energy efficiently and is likely
spread spurious radiation where it
not wanted. As the spectrum gets
ore congested we may expect that
strict regulations about spurious
ission made by radio licensing
thorities will be tightened further.

imum Energy

re fundamentally, all energy trans-
tted is capable of causing interference,
der some circumstances, with other
io users. Often energy from two or
ee transmitters combine in the
eiver to produce a spurious response
ich destroys the intelligibility of the
nted signal. It is not good enough
ply to radiate a very 'clean' signal
m the transmitter, for even the
rgy which forms part of the wanted
nsmission is itself capable of creating
polluting effect for other users.
other cardinal principle must there-
e be that in all cases the energy
iated should be the minimum needed
the job the system is designed to

must recognize that radiating a
stantial carrier wave in AM or FM
nsmission does pollute the spectrum.
the whistling sounds produced by a
io receiver in a congested band are
sed by carrier interactions, which are
re serious in their effect than inter-
ons between energy from sidebands.
ause the carrier wave is of constant
plitude and frequency, and the
son receiving a signal knows its fre-
ency in advance, in principle at least
ought never to be necessary to radiate
carrier at all. In practice, it may be
tly to generate it accurately enough
the receiver, so it is quite common-
ce to simplify the receiving equipment
radiating a substantial but reduced carrier along with the sidebands. In a typical AM transmitter modulated by speech, on average 90 per cent or more of the radiated power is in the carrier. This means that less than 10 per cent of the radiated power is performing an inescapable communication role and the rest is needlessly generating spectrum pollution, and is retained only to make the receiving equipment cheaper. This may have been justified in an era when the spectrum was relatively uncluttered, but today it should be looked into very closely.

Single-sideband modulation, with a suppressed carrier, is, as we have seen, a perfectly feasible means of transmission, already in widespread use in the shortwave (HF) bands. Not only does it cut the width of the transmitted spectrum by about half, but it avoids emitting radio energy other than the minimum necessary to establish the required communication link. It is therefore our best ally in the fight against spectrum congestion. Recently in the United States the Federal Communication Commission gave wide circulation to a document — the UHF Task Force Report — which strongly supported the extension of SSB into the VHF and UHF bands for land mobile radio. Surely this must be a straw in the wind.

Costs

The disadvantage of SSB is the tighter specification which has to be placed on the equipment, which is thought likely to be considerably more expensive. Against this, present trends in electronics are bringing equipment costs down so rapidly that perhaps the handicap will prove much less than had been imagined.

Probably it is in two-way radio systems rather than broadcasting that SSB will first capture a new empire for itself, and my colleagues and I at the University of Bath have been able, thanks to generous support both from the UK Home Office Directorate of Telecommunications and the Wolfson Foundation, to conduct an investigation into the use of SSB modulation in the land mobile radio service at VHF and UHF. As a result we are convinced that operation in channels only 5 kHz wide is perfectly feasible, as against the 12.5 kHz or 25 kHz channels now used for AM and FM. Because carriers are not transmitted, the total energy radiated is reduced by a factor of about eight when speaking, and to a very low level in between words. To our surprise it appears that the cost of the equipment may be very little more: the saving from the reduced transmitter power rating tends to offset increased costs elsewhere.

If we exploit all possible technical resources, the problem of exhaustion of the electromagnetic resource can be postponed, at least for a generation. Should we fail to take sensible steps, things could only worsen. The economic toll already is certainly not trivial, and deaths have occurred through the congestion.

Capital Investment

It is, of course, true that spectrum exhaustion is not like exhaustion, say, of hydrocarbon fuels. The spectrum is not used up or worn out by use, and we can always free it again by simply turning off the transmitters or interference sources. Though this is true, it is not a helpful observation. Established patterns of radio use have led to large capital investments which cannot lightly be put to one side. To take an example, radio equipment in the hands of UK police forces is now perhaps worth some £20 million sterling. In theory they could change to an entirely new radio system within days of having new equipment provided for them, but in practice, and quite rightly, only the most compelling reasons would cause this large capital investment to be abandoned. Much the same is true of every other user.

This means, first, that changes will have to be introduced in an evolutionary way, as equipment is inevitably replaced through age and obsolescence, and, second, that because there is this large inertia we must be particularly careful that new systems coming into use do not offend against the needs of spectrum conversation. If any such systems were inadvertently allowed to be installed, the chance of phasing them out again quickly would be small indeed. We should now be directing some of our best engineering talent to spectrum conservation. It would be foolhardy if we were not to insist on the highest attainable technical standards in the design of all our future communication systems that use radio. It is high time that we stopped trying to reassure ourselves that the spectrum congestion problem does not exist or will go away. It is with us now, and it threatens the future of us all. We must learn habits of frugality, and who can not say that if we do so in this field the gift for it may yet spread to others?

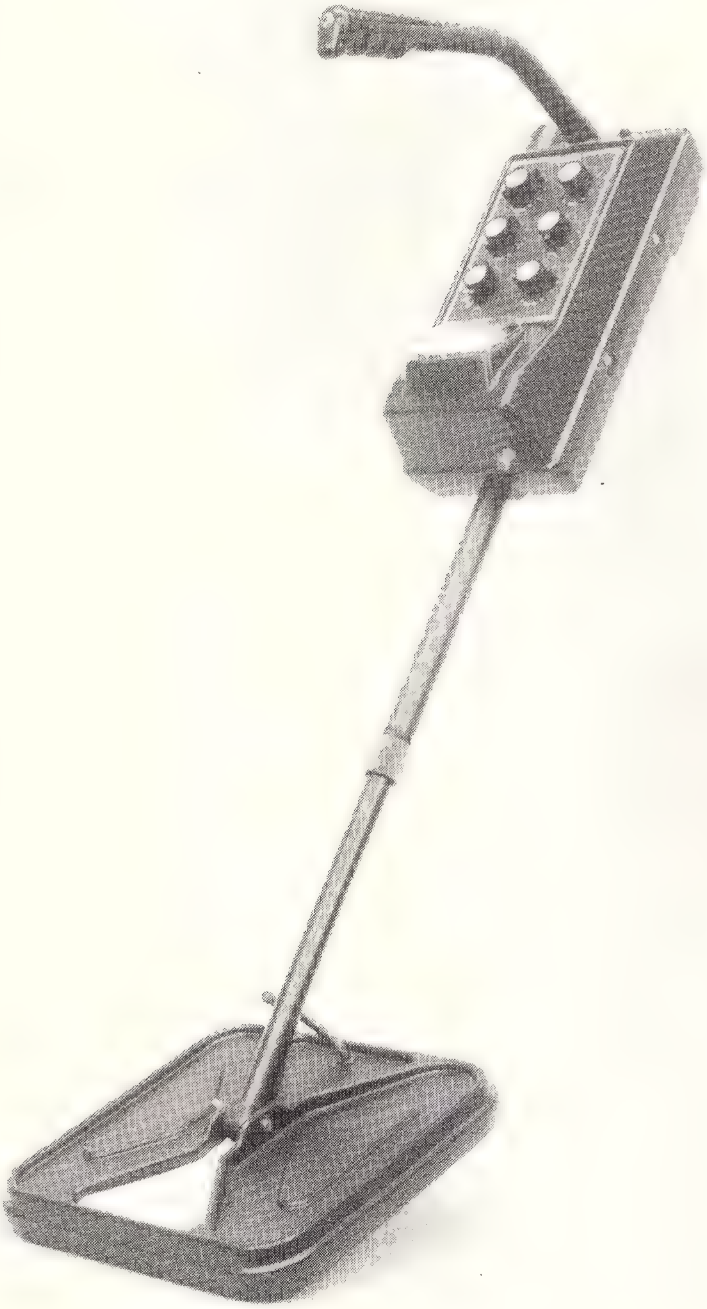
By Professor W. Gosling,
University of Bath.
Spectrum 164.

(707 S)

metal detector

high performance and simple construction

One of the problems that govern the fast growing hobby of treasure hunting is that economical metal detectors are notoriously unstable and suffer from a lack of sensitivity while the good ones are very expensive. The design featured in this article is both highly stable and sensitive and presents no problems in construction. It is professional in appearance and operation and performs better than many high-priced commercial detectors.



One of the projects near the top of c 'most requested projects' list has, some time, been a metal detector. T reason for the delay in publishing article on the subject is due to the f that construction of a good detec (and not one that just detects sor thing) is a very difficult propositi The very first major problem that re its head is that of stability since thi dependent on a number of aspects. achieve a stable circuit design is not e when cost is taken into consideratio The design and construction of search head is also a formidable obstr tion to obtaining a high performa while still remaining within the ca bilities of the average enthusiast.

Furthermore, the search head must robust and remain stable after the v critical setting-up procedure it requi In other words, it must not be prone 'headaches' when knocked. Even difficulties of waterproofing and res ance to temperature changes problems enough in themselves if others are not enough.

What of the circuit itself? There are course, a number of methods by wh metals can be detected with the use electronics but stability is the govern factor in performance. It is possible design a circuit using microprocess and the like that will work wonders b will require a find of gold sovereig every day for a week to cover its cost

Overall, the difficulties will appear now to be unsurmountable and y may well be asking how we managed do it at all. It took a little time but, r assured, it has been done and the resu have been well worth waiting for. T Elektor metal detector performs v well and is easy to construct due to fact that the ultimate horror — search head — does not have to be c structed by the reader. A compl hardware assembly, including the he is available to readers, ready-made.

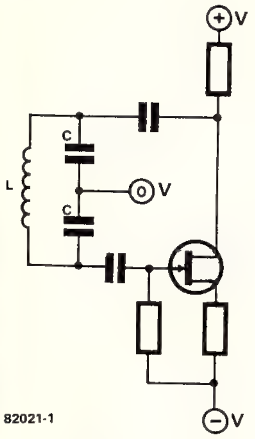
How has it all been done? Bef reading on to find out, a note warning. Firstly, reading the arti carefully and paying attention to de during construction are essential produce a high performance me detector. Secondly, and not quite obvious, treasure hunting with a metal detector is much like horse ridi it takes time and practice to beco proficient at it. Don't expect it happen in one day!

Surveying the field

Various methods are used in the des of metal detectors and they all h their various advantages and disadv tages.

BFO — beat frequency oscillator

These units are cheap, easy to build, suffer due to the high frequencies u (for economic reasons). They are very sensitive to metals, suffering ba from instability and ground effect a they do not discriminate between diff



re 1. A simplified diagram of a ventional oscillator circuit. No form ompensation is included to allow changes in the value of capacitor C to temperature variations.

2

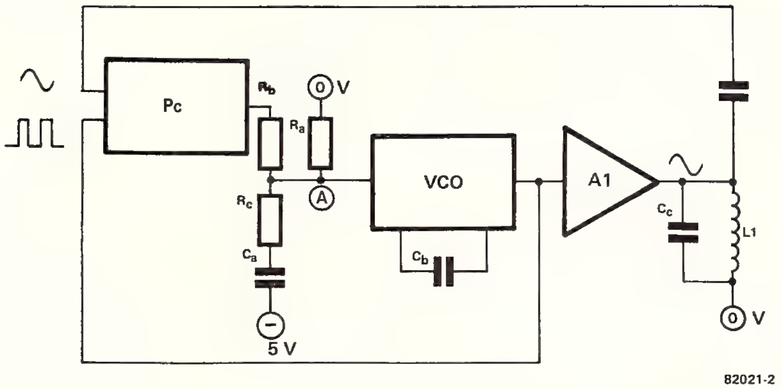


Figure 2. The Elektor metal detector employs a phase locked loop design to provide the basis of a highly stable oscillator with immunity to drift.

materials. They work on the hetero- e principle of beating two fre- ncies together and obtaining an io tone relative to the difference veen the two signals. The basic trick ıat the oscillator has the search head :s frequency determining component inducing a metal object into its ıity will increase or decrease the ch frequency so producing a change udio tone.

B — transmit-receive/induction-balance

se metal detectors are much better BFO types as regards general itivity but still suffer from stability ılems and do not discriminate be- ın metals. This type requires very ırate relative positioning of the coils can be extremely difficult to set up. ther disadvantage is the fact that a ıt knock 'on the head' can cause signals.

— very low frequency

most expensive metal detectors are ılly of this type. Various circuits (a) make the unit sensitive to als, (b) discriminate between metals (c) provide ground effect control overcoming a lot of shortcomings rent in cheaper detectors. However, to the low frequencies used, these ıs still suffer from instability. The dvantages are cost (which can be) and difficulty in setting up the l assembly.

pulse induction

e induction is used in professional industrial metal detecting systems. ɔod design can be extremely costly construction and calibration is ɔnd the realms of the average elec- ics enthusiast.

Elektor metal detector to be de- ɔed is a high performance VLF lel utilising phase locked loop ıniques for stability, good discrimi- on between metals and elimination ground effect. It features a better detection range than BFO and TR/IB types and does not suffer from instability problems. To achieve all this 'icing on the cake' it will be obvious that the circuit must therefore be more complex. However, a glance at the circuit diagram in figure 4 will show that it is not as complicated as some readers may have expected, and furthermore calibration is extremely simple.

Instability and PLL

As previously mentioned the major disadvantage of cheaper metal detectors is that of instability. In cases of severe instability, the process of detecting metal can be hampered to the degree that it becomes impossible to differentiate between the detector itself being 'off tune' and a 'find'.

Why is the Elektor VLF circuit more stable than others? The simplified circuit diagram in figure 1 is that of the more conventional VLF design. The problem is that the low frequencies used with a VLF design require a large number of turns in the search head coil. This also necessitates that the value of C in the circuit is relatively large. This is the point in the circuit where instability will occur since any capacitor will change value when exposed to heat. If it happens that the capacitor is included in the tuned circuit of an oscillator, it follows that the oscillator frequency will therefore be prone to drift.

In this type of oscillator the drift cannot be compensated for and the problem is further aggravated by the susceptibility of the circuit to voltage fluctuations in the power supply (creating more instability). As if this were not bad enough, the oscillator has a fairly high current-consumption and therefore batteries have a very short life.

To overcome these shortcomings the Elektor phase locked loop design was developed. This effectively compensates for any drift in the oscillator frequency due to changes in the value of the capacitor. This design is slightly more complex but with the help of figure 2 is fairly easily understood.

The centre frequency of the VCO (Voltage Controlled Oscillator) is initially set by Ra, Rb, Rc and Ca, Cb. This produces a square wave, which is converted into a sine wave by the amplifier A1 and is fed to the search head L1. A proportion of this signal is capacitively coupled back to the input of the phase comparator PC, the output of which is passed to the control input of the VCO via the low pass filter consisting of Rc and Ca. The output of the VCO is also fed back to the other input of the phase comparator. These two feedback loops provide an immunity to drift and form the basis of this highly stable oscillator.

The Elektor metal detector

It has already been stated that the circuit of the metal detector is fairly complex. However, the diagram in figure 3 shows the details of the circuit in block form and it will be understood more easily if each block is treated separately, bearing in mind that each one refers to a section of the main circuit in figure 4.

Since the first block of the diagram, the PLL oscillator, has already been described, we can move on to the phase locked loop discriminator. A discriminator enables the user to reject unwanted materials, for example metal paper foil. This part of the circuit has again been designed with high stability in mind and for this reason a second PLL is used. The adjustment of the phase relationship between the transmit oscillator and the received signal, provides a method of sampling a proportion of the received signal. This provides the phase sensitive detector with its gate input.

The phase sensitive detector 'chops up' the input signal from the receive head and, after filtering, the DC voltage output is used by the meter and audio circuits.

The auto tune is another special feature of the Elektor metal detector. Briefly the principle is to achieve an offset voltage, by storing it in a capacitor across an FET opamp which is used as a slow/fast integrator. By feeding this voltage level back to the phase sensitive detector we can reset the output voltage of the PSD, in order to zero the meter at the flick of a switch. This means that manual retuning is not necessary when changing modes or altering the sensitivity of the detector.

The meter circuit is straightforward and incorporates a battery status check, as well as indicating the accepted and rejected finds.

The final section of the block diagram is the audio stage, but this does not consist solely of an ordinary amplifier. A gated chopper circuit is also included which takes the search oscillator frequency and divides it down to approximately 270 Hz. This is used to chop the DC voltage output of the PSD before feeding it to the audio output amplifier thus providing an audio tone when metal is received.

This covers the basic building blocks of the metal detector and we can now move on to discuss the finer points of the circuit in detail.

The circuit diagram

The PLL oscillator is formed around IC1 in the circuit diagram shown in figure 4. The frequency is set by the components C3, R12, L1 (the search head), C2 and R10. The value of R10 is chosen to set the VCO initially at mid frequency. The square wave output of the VCO (pin 4) is coupled via R7 to the search amplifier which is formed by transistors T1 . . . T4. A portion of the sine wave is fed back via C1 and R11 to the signal input of the phase comparator (pin 14) where it is compared to the signal at pins 3 and 4. The resultant output at pin 2 is used to adjust the VCO to its resonant frequency thus forming a stable oscillator.

The VCO output at pin 4 of IC1 is also fed to the input of the phase locked loop discriminator IC2. The configuration of this IC provides a convenient method of adjusting the phase relationship by simply changing the value of a resistor at pin 11. The actual 'resistor' value is selected by S1, P4 and P5 and the resistor networks connected to pin 11 pf ES5 and pin 8 of ES6. The level at pin 11 of IC2 selects either ground effect or reject mode with the aid of the CMOS switches ES5 and ES6.

The phase shifted square wave output of the discriminator IC2 is the gate signal for the phase sensitive detector formed by IC4 and A2. The receive signal from the search head is passed through an impedance converter T12 and then amplified (by a factor of 50) by the opamp A1 before being passed to the phase sensitive detector. It is this signal that is then chopped and sampled
IC4 and converted to a DC voltage le
by opamp A2. The gain of this stag
variable by means of potentiometer P
The output of A2 is a voltage level t
varies in relation to the size and cont
of any metal object in the proximity
the search head. This signal is r
provided with a variable offset by
tune control P7 in order to allow
meter to be zeroed.

Manual tuning can become tedious i
is required after every change of m
and therefore an auto tune is a desira
feature of the circuit. This is carried
by storing a voltage level in C18. T
voltage is the sum or difference of
output of A2 and the position of
tune control. A4 together with IC6 fo
the basis of the auto tune circuit wh
functions as follows. When the t
CMOS switches S3 and S4 close,
output of A4, an opamp with a g
of 4, will be fed directly to the in
of IC6 and cause this opamp to act
fast integrator. Since its output is
back to the non-inverting input of
the original voltage level on the out
of this opamp will be restored. A
tune is brought into operation
flicking the handle switch S3 mom
tarily. This action will turn on
CMOS switches ES3 and ES4 t
increasing the voltage level on pin 2
IC6 by a factor of 4.

S3 also serves as the mode cha
switch when operated in the ot

3

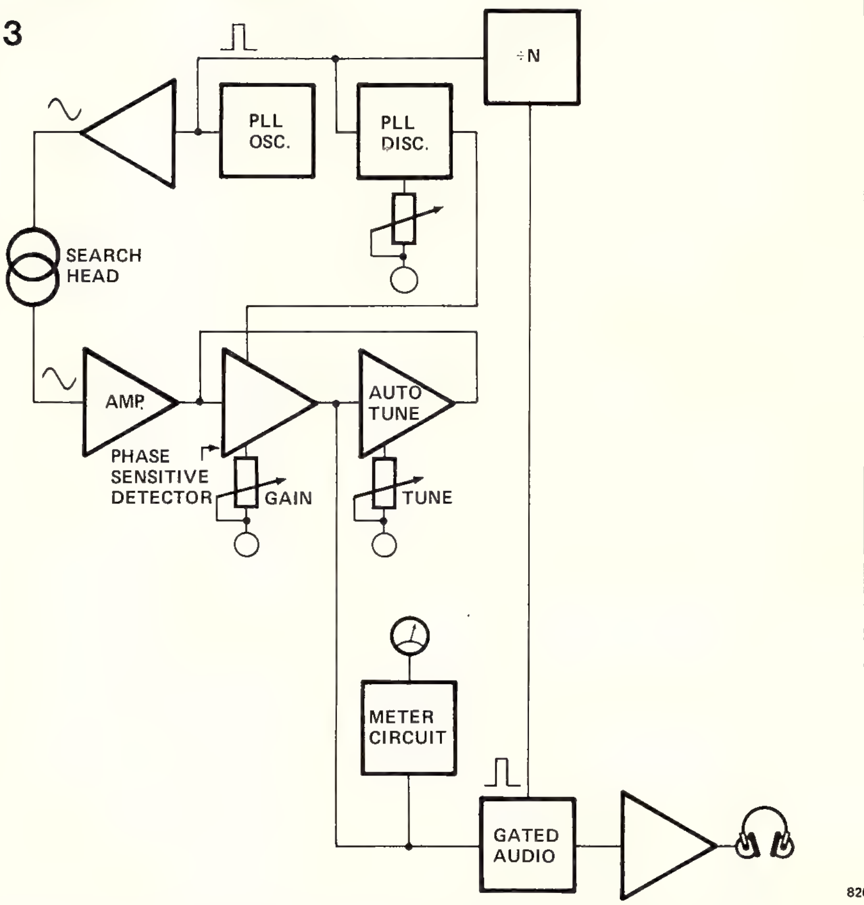


Figure 3. The block diagram of the Elektor metal detector. Each block corresponds to a part of the circuit diagram in figure 4.

1

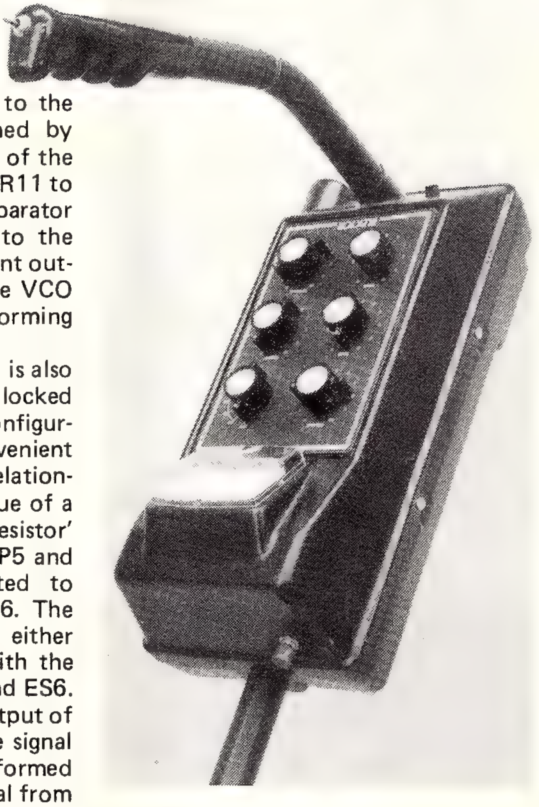
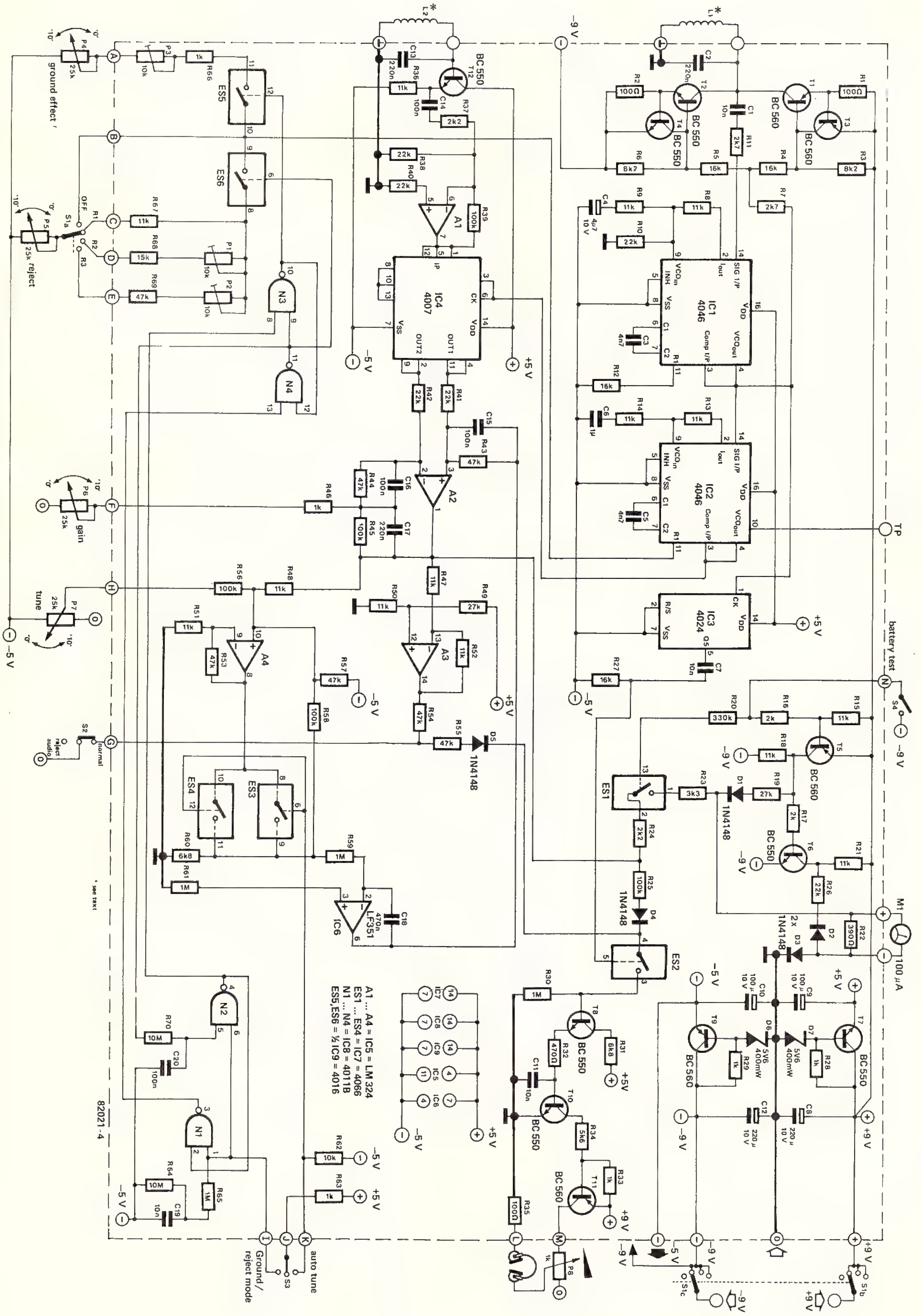


Photo 1. The handle and case assembly of the metal detector showing the high standard of the finished project.



ure 4. The complete circuit diagram for the metal detector. This drawing can also be used for wiring information for the tches and potentiometers.

direction, changing from ground effect to reject mode or vice versa. It will be apparent then that S3 is effectively a three-way switch. Mode change is achieved by the gates N1 . . . N4 which are configured as a flipflop (although they may not appear to be so in the circuit diagram!). The complementary outputs of the flipflop control the two CMOS switches ES5 and ES6.

Many readers may find the going a little tedious by now, but take heart: we are almost at the end, in fact only the meter and audio sections of the circuit are left. The two functions of the meter are selected by the CMOS switch ES1. This is 'normally closed' and the meter will be connected to the detector circuit. Pressing the battery check switch S4 will open ES1 and at the same time, cause T5 and T6 to conduct. The meter will now be connected across the batteries via R19/D1 and R26/D2.

The remaining part of the circuit is the audio stage. It is slightly unusual but fairly straightforward. The output from the PLL oscillator (IC1) is fed to IC3 where it is divided by 32 to produce a 270 Hz square wave. This is then 'sharpened' by C7 and R27 to provide a control pulse for the CMOS switch ES2. In the normal modes an audio signal will only be heard when the meter moves to the right, indicating the presence of a wanted 'find'. This is when a rising positive voltage appears at the output of A2 and is fed via R25 and D4, through the CMOS switch to the output stage via T8.

It is also possible to use an audible signal for rejected finds. This may not be obvious at first but after some experience with the metal detector this feature will be found to be a useful extra. When S2 is switched off, the output of A3 is allowed to pass, via R55/D5 and again ES2, to the output stage. The audio amplifier consists of transistors T8, T10 and T11 with T10 acting as a level converter.

Construction

Readers will be in no doubt by now that the Elektor metal detector has a very professional appearance and in no way suffers from the usual nuts, volts and tobacco tin look that usually grace home construction projects of this type. The good news is that, yes, your metal detector can look exactly the same as that shown in the photograph here. Even more important, the major problem that prevents construction of a really good metal detector, that of winding and setting the coils in the search head, is completely taken care of. The entire case and hardware assembly, together with the potted, waterproofed and tested search head, has been made available to readers via Crestway Electronics Limited and it can be purchased with or without electronics. The overall design is to fully professional standards and the finished metal detector will outperform many high quality commercial units.

Should any reader wish to produce his own search head it is just possible although not very practical, since the setting of the coils is extremely critical and their position makes the difference between a very good detector and no detector. However, for those interested the head consists of two 10" coils with 80 turns each of 29 swg enamelled copper wire slightly flattened (to form a D) and overlapped by approximately 1". The critical setting is then found by trial and error.

The electronics of the metal detector surprisingly easy to construct. In fact, the printed circuit board is used, it w present no problems at all. Assembly the board is carried out in the usu manner after which the point to poi wiring is completed, using figure 4 as guide.

Particular attention should be paid the wiring of the potentiometers or t direction of the rotation may be inco rect. If one of them does appear to the wrong way round, exchanging t

5

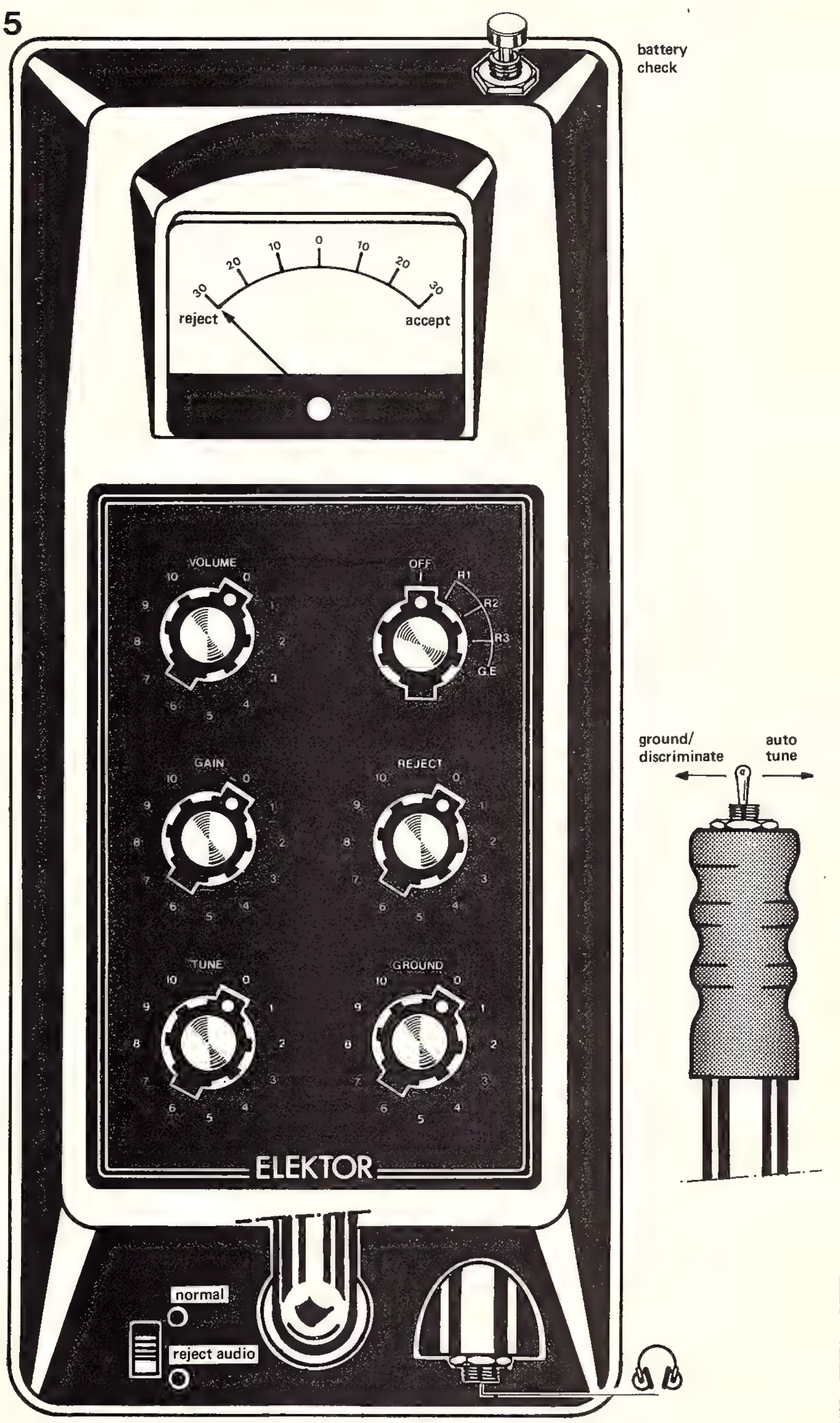


Figure 5. The front panel layout and controls for the metal detector. It is important that the switches and potentiometers are wired correctly. This diagram can be used with the operating instructions.

ring at each end of the track (the outle tags) will provide a solution.

ie handle switch S3 (ground effect/ ect mode and auto tune) is a momenry two-way switch with a biased ntre off position. This must be wired rrectly to avoid confusion in use. The itch should be fitted so that auto ne is operated when the switch is cked to the right. The contact that is ade' in this position (usually the leftnd one) should be the one connected K on the printed circuit board.

note on the printed circuit board, ere are two points marked −9, these ve to be wired together externally. If reo headphones are used they should converted to mono by shorting the t and right leads together (not the mmon lead).

will be wise to ensure that all connecns are correct before connecting the tteries.

libration

ny electronic device will only be as od as its calibration and for this ason the setting of the three preset tentiometers P1, P2 and P3 should be rried out with care. Some readers tend get a little alarmed at this point but can dispel any worries right away. e metal detector has been specifically signed to allow the calibration to be rried out — with nothing more sophisated than an ordinary multimeter th reasonably accurate 1 V and 10 V nges.

tially all controls must be turned ly clockwise. The unit can now be itched on by turning S1 to the R2 sition. The first check is the positive pply rail and this is carried out by nnecting the meter (switched to V DC) across C9 — taking note of the larity. The reading should be between V and 5.3 V. The negative supply n be checked across C10, again with ention to polarity, and in this case a ading between −4.7 V and −5.3 V ll be fine. If either reading is outside ese limits the components in the sup- regulators must be checked before ing on.

the supply voltages are correct the eter can now be connected between e test point (TP, pin 10 of IC2) and V (negative lead). With the meter itched to the 1 V range adjust P1 for reading of 0.55 V. Switch S1 to the position and adjust P2 for a reading 0.15 V. After flicking the handle itch to select ground effect mode, P3 n be adjusted for a reading of 0.82 V. nd that is all — the calibration has en completed!

perating instructions

. Switch S1 to the R3 position.
. Press handle switch S3 to right and hold.
. Rotate tune control until meter reads zero.
. Rotate gain control to position 8.
. Release handle switch.

2

Photo 2. Possibly the most important part of the metal detector, the search head, is supplied as a complete and finished assembly.

6. Adjust volume control to 1/2 way position.
7. Using a gentle sweeping motion sweep the ground in front of you with a left-right-left movement while walking slowly forward. The maximum sweep should be about 18″.
8. Practice for a while using this procedure and try to receive signals from all types of metal.

Once you are confident in the use of the basic procedures of the machine then move on to the following: using steps 1-6 set up the machine in basic operation mode and carry on with the following steps.

9. Flick handle switch to the left and release.
10. Rotate the reject mode control and check that the mode is correctly selected by a swing on the meter, if not return to step 9 and repeat.
11. Switch S1 to the R2 position and set the reject mode control to 1/2 way.
12. Flick the handle switch to the right (auto tune) momentarily and release.
13. At this point you should be rejecting tinfoil silver paper etc. but accepting coins (cupronickel) bronze, brass, silver and hopefully gold.
14. Rotation of the reject control towards zero will decrease the amount of rejection, and towards 10 will increase rejection.
15. Practice using the above until you are familiar with the machine, then try the following.
16. The coarse settings of positions R1, R2; R3 on S1 works as follows:

R1 will give the maximum rejection of metals:

R2 will give average rejection and is the most used position.

R3 will give a minimum metal rejection, in other words, receives most metals.

17. **Ground effect control**

On some soil the so-called ground effect may be experienced, due to mineralised soil. The same effect will appear when using the detector on beaches. This phenomenon produces the effect of an almost continual and apparently haphazard series of finds. The indication of ground effect can be verified by a drop in audio output when lifting the search head away from the ground. It must be noted that ground effect is a phenomenon that all metal detectors have to overcome. The Elektor metal detector is able to eliminate this problem when the procedure described here is followed:

18. Depress handle switch to the left momentarily and release.
19. Rotate the ground effect control whereupon the meter should move.
20. Adjusting this control from zero to 10 will increase or decrease the compensation for ground effect and the best setting is when you can lift the head away from the ground, with no change of signal.
21. **Gain control**, this control sets the sensitivity of the machine and is normally turned up towards position 10 for most of the time. However, if a beach is being searched for coins, which will usually be just on the surface, then turning the gain down will make the detector sensitive to coins on or just below the surface and anything buried deeper will be ignored.
22. **Auto tune switch**

At any time in use, if changing mode or resetting of the gain, reject and ground controls, then momentarily operation the handle switch to the right will reset the tune position back to zero

3

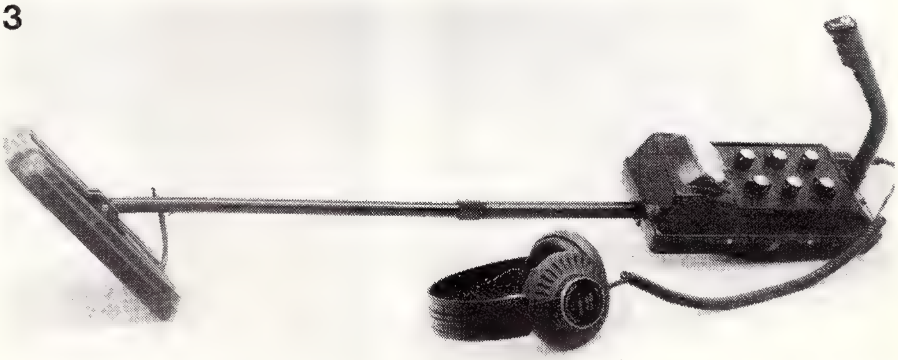


Photo 3. The distance between the head and the handle is fully adjustable.

Parts list

Resistors:

R1,R2,R35 = 100 Ω
R3,R6 = 8k2
R4,R5,R12,R27 = 16 k
R7,R11 = 2k7
R8,R9,R13 . . . R15,R18,R21,R36,R47, R48,R50 . . . R52,R67 = 11 k
R10,R26,R38,R40 . . . R42 = 22 k
R16,R17 = 2 k
R19,R49 = 27 k
R20 = 330 k
R22 = 390 Ω
R23 = 3k3
R24,R37 = 2k2
R25,R39,R45,R56,R58 = 100 k
R28,R29,R33,R46,R63,R66 = 1 k
R30,R59,R61,R65 = 1 M
R31,R60 = 6k8
R32 = 470 Ω
R34 = 5k6
R43,R44,R53 . . . R55,R57,R69 = 47 k
R62 = 10 k
R64,R70 = 10 M
R68 = 15 k
P1 . . . P3 = 10 k preset potentiometer
P4 . . . P7 = 25 k lin. potentiometer
P8 = 1 k lin. potentiometer

Capacitors:

C1,C7,C11,C19 = 10 n MKM
C2,C13,C17 = 220 n MKM
C3,C5 = 4n7 ceramic
C4 = 4µ7/10 V
C6 = 1 µ MKM
C8,C12 = 220 µ/10 V
C9,C10 = 100 µ/10 V
C14 . . . C16,C20 = 100 n MKM
C18 = 470 n MKM

Semiconductors:

D1 . . . D5 = 1N4148, 1N914
D6,D7 = 5V6 400 mW zener diode
T1,T3,T5,T9,T11 = 2N4126, BC 560
T2,T4,T6,T7,T8,T10,T12 = 2N4124, BC 550
IC1,IC2 = 4046
IC3 = 4024
IC4 = 4007
IC5 = LM 324
IC6 = LF 351, 3140, or equ.
IC7 = 4066
IC8 = 4011 B
IC9 = 4016

Miscellaneous.

S1 = three-pole four-way switch
S3 = SPDT biased centre off switch
S4 = single pole push to make switch
S2 = SPST slide switch } included in complete
L1,L2 = search head } casework kit from
M1 = 100 µA meter } Crestway Electronics Ltd.
headphones = 8 Ω
batteries = 2 x PP6

A complete kit of parts including all metal work is available from Crestway Electronics Limited.

6

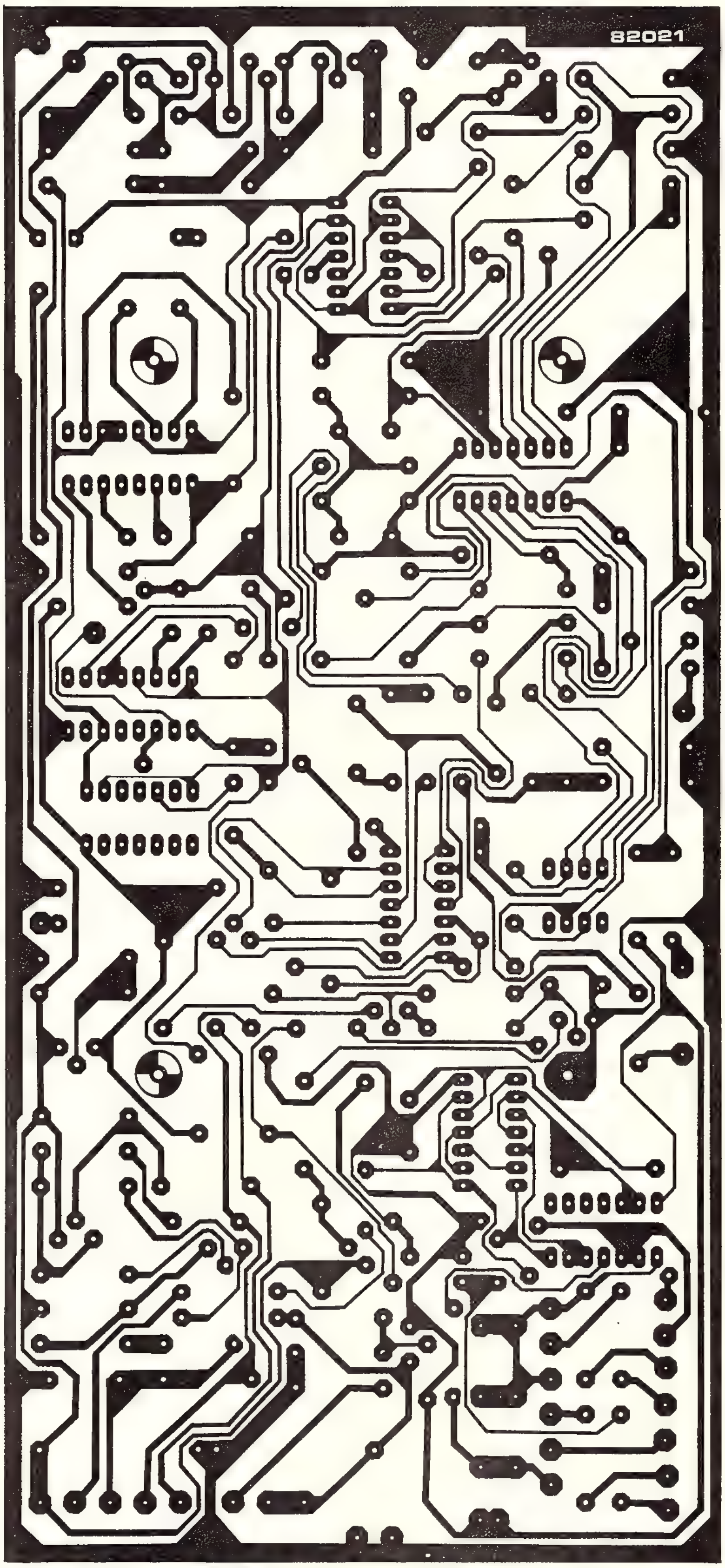
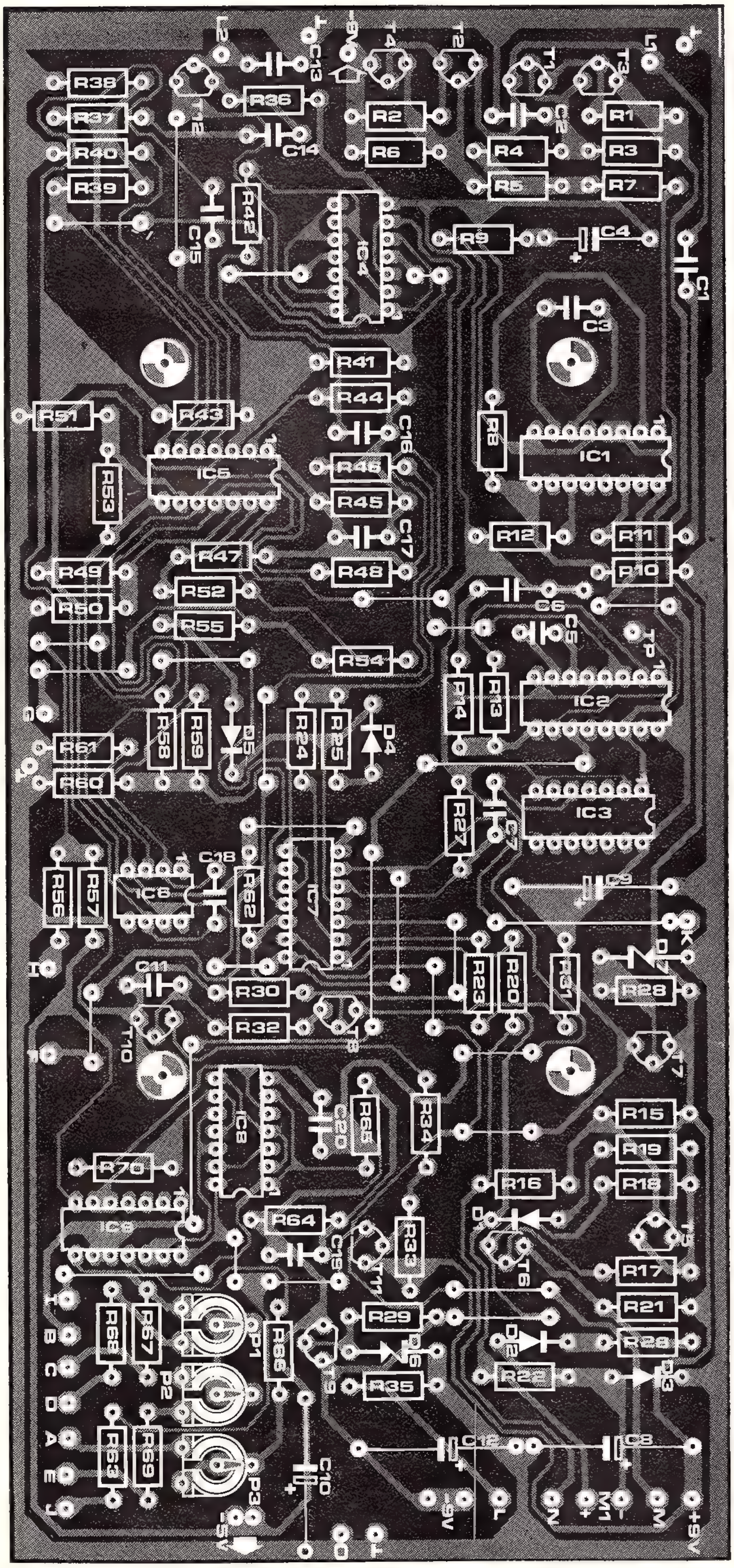


Figure 6. The printed circuit board and components layout for the metal detector. The two points marked −9 are wired together externally.



on the meter, but note: do not hold this switch over while actually searching for metal as the fast integrator circuit will be constantly in use.

23. The slide switch S2, at the left hand rear of the case, is normally in the nearest position to the front panel. This corresponds to an audible indication when the meter moves towards the right. If the switch is in the other position then an audio signal will be present at all times whether the meter is moving towards the right or the left, but a change in tone will be heard as metal is detected. This mode is useful for general searching, since you do not need to look at the meter all of the time.

24. **Battery test button**
Pushing this will give a meter reading indicating the state of the batteries. The batteries should be replaced when the meter reading falls below 10 on the right hand half of the scale. ◾

Notes for treasure hunters

Successful treasure hunting with any metal detector requires plenty of luck and experience. We are of the opinion that the former is somewhat unreliable but the latter can be gained with practice. After a period of use and time in which to become familiar with the metal detector, you will get to know little tricks like telling the difference between ferrous and non-ferrous materials from indications given by the detector alone. Steel is indicated by a more rapid movement of the meter. It is not really understood why, but bronze tends to give a warbling note in the headphones. Small coins and rings lying on edge in the ground will produce a very sharp on/off signal. It is also useful to know that the larger the size of a buried object, the more area the signal will be on for. We are also reliably informed that gold actually gives a double pulse in the form of an echo.

For consistent results, do not move too fast (neither sweeping nor walking) and keep the head within 1/2 to 1 inch above the ground. This becomes a lot easier with practise. After use always clean the search head with a damp cloth.

Above all, respect other people's property, and request permission before searching an area of land, it is almost always granted. The Elektor metal detector head is perfectly water-proof and can therefore be used in rivers which can prove quite fruitful.

We are given to understand that growing a beard and rising at unheard of hours does bring a measure of success but we have no documentary evidence to prove this. The seasoned treasure hunter can be recognised by this downcast, glazed expression and constant mumbling. His hand never leaves the shovel that travels everywhere at his side and he wears headphones in bed!

Treasure hunting can be rewarding, frustrating and damaging to your social life but it will never be boring.

high boost

A.M. Bosschaert

All electric guitars and bass guitars have some sort of tone control, although this is generally very unsophisticated. This high boost circuit can provide a great improvement, for, as its name suggests, the treble can either be boosted or cut by about 35 dB. In addition, the turnover point of the tone control can be set to three different frequencies by means of a single switch.

It is a well-known fact that for some inexplicable reason, electronics has never succeeded in catching up with the quality of electric guitars. The average tone control circuit on an electric guitar usually consists of little more than a capacitor and a potentiometer and can hardly be expected to produce very good results. An active tone control is much more effective and the high boost circuit, for instance, can either amplify or attenuate the treble over a ± 35 dB range. The circuit is compact in size, allowing it to be fitted inside the guitar body, if desired. Its current consumption is low enough for a battery to be used as a power source.

In addition, the tone control is equipped with a turnover point switch. Understandably, not every guitar owner is going to be prepared to cut holes into his/her precious instrument. Taking this into account, the circuit enables both the treble and the turnover point to be selected with a switch that is possibly already fitted to the instrument (as in Stratocaster and Les Paul copies, for instance). This means that the guitar can be provided with a number of practical facilities without having to be disfigured.

Operation

Figure 1 contains the tone control circuit diagram. At the heart of the circuit, IC2 constitutes an active tone control together with R5 . . . R9, P1, C3 and C4. The tone control is preceded by an emitter follower that is built up around T1. This serves as a buffer for the high-impedance guitar pick-up at the circuit's input.

The DC offset of IC2 is determined by the resistors R10 and R11. As a result, half the supply voltage is fed to the IC's non-inverting input. The output of the opamp also determines the bias of T1 via resistors R3 and R4 in the feedback loop. The opamp used is not a common type, but has been selected for this purpose because of its low current consumption.

As mentioned previously, the tone control uses a three-position switch to select one of the three turnover points: 250 Hz, 800 Hz and 2500 Hz. The setting is altered by means of electronic switches which connect R8 and R9 in parallel to P1. The electronic switches, ES1 and ES2, are controlled by the D-type flipflops FF1 and FF2. These are wired so that the count cycle is as follows: 00-01-10-00-01-etc. When the count is 00, no resistor will be connected in parallel to the potentiometer and the turnover point will be at its lowest level (250 Hz). When the count is 01, however, ES1 will switch on, so that R8 will be connected in parallel with P1 and the turnover point will be at 2500 Hz. Then there is the 10 count, where R9 is in parallel to P1 and the turnover point frequency becomes 800 Hz.

Switch S1 controls the FF1 and FF2 counter. This switch is operated with the aid of P1. A type of monoflo made using the two other electr switches in IC3 for the purpose switch debouncing. Operation is as lows. P1 is usually turned to adjust treble. If a different turnover point quency is required, the potentiomet turned fully anti-clockwise, then opening the switch in the pot. potentiometer is then turned in opposite direction. Now the tr control can be adjusted as requi After the switch has been opera three times, its initial turnover quency will be restored.

S1 can also be operated independe from P1. For this S1 must be repla by a pushbutton type. Depressing pushbutton will then step through turnover frequencies.

The current consumption of the cir is exceedingly low, slightly over 0.5 r which means that the circuit r comfortably be powered with a sr 9 V battery.

Construction and setting-up

Figure 2 shows the printed circuit bo on which all the components mounted. The board is small enough be fitted inside a guitar, but it can be housed in a separate case, which r be preferable for aesthetic reasons.

Most electric guitars have at least potentiometers: one acts as a volu control and the other as a tone cont All that has to be done therefore i replace them by two different ty P1 is a potentiometer with a bui switch. The switch is indicated as S the circuit diagram. The volume cont P2, is a 'normal', logarithmic type.

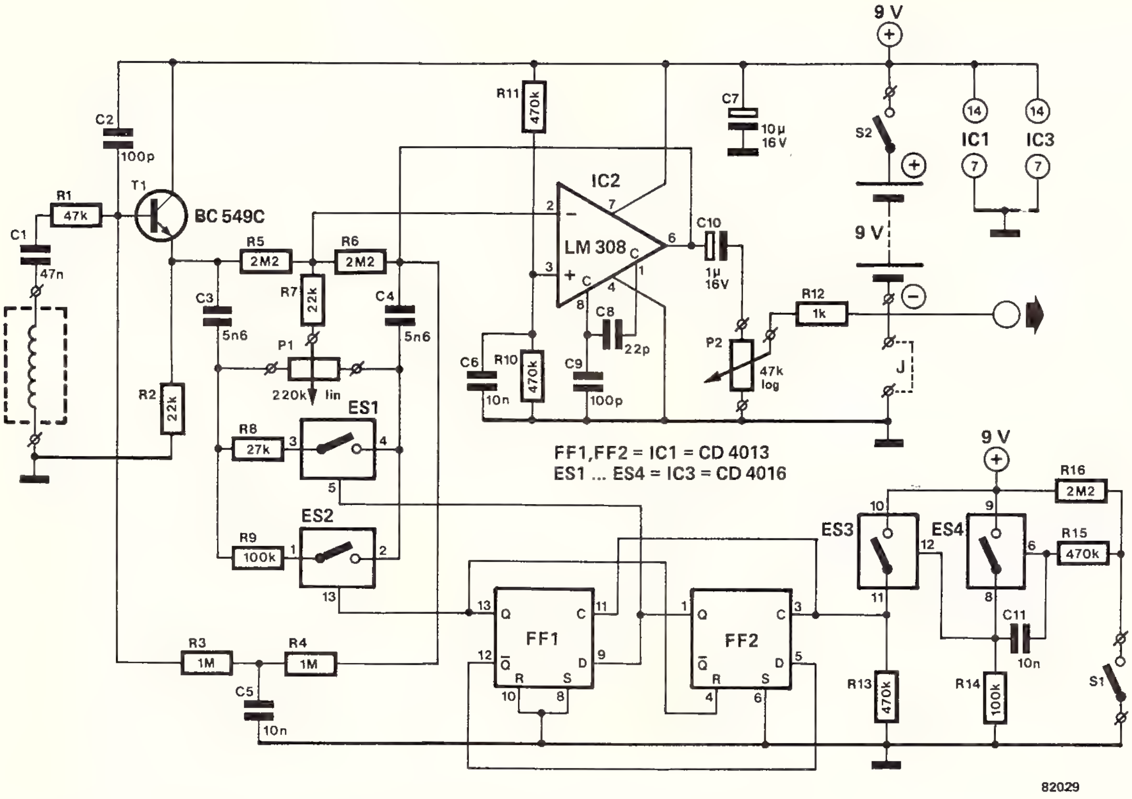
The potentiometers and switch S1 now connected up to the printed cir board and so are the guitar pick-up the battery. There are two possibil for switching the power on and off. first involves using the supply switch which means linking the dotted J nection on the board.

The second alternative is a slightly r elegant solution. The jack socket on guitar is replaced by a stereo vers When the plug is inserted, a 'shor caused between the connection for spare amplifier channel and grou since the plug is a mono type. By necting the negative terminal of battery to the second channel con tion of the socket and the circuit e to that of the socket, the power sup will be switched on automatically w the lead is plugged into the guitar.

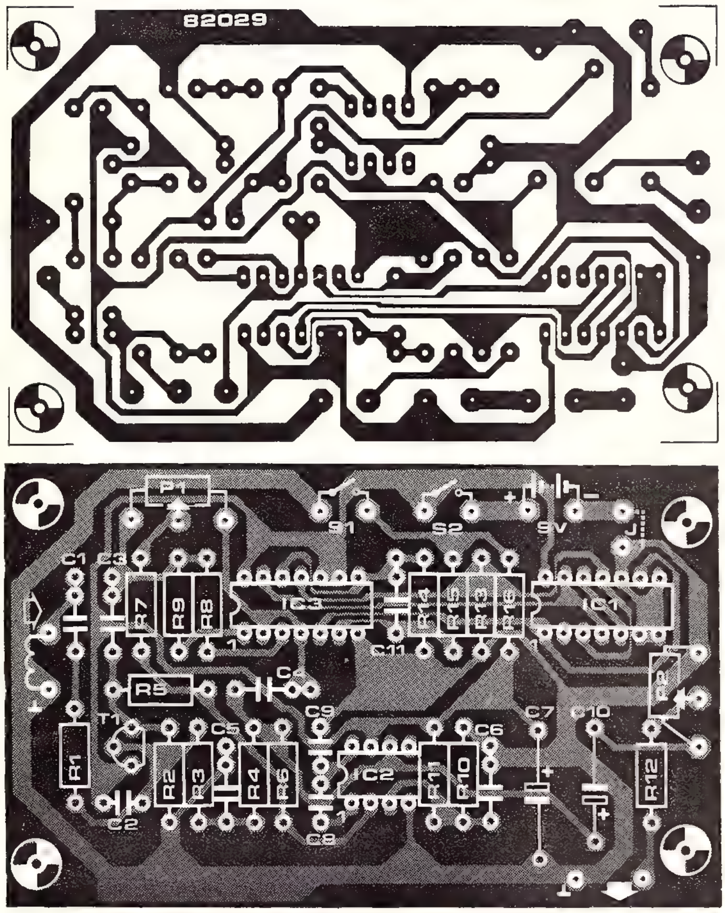
If housed in a separate case, the cir may be provided with a small m power supply. After all, the cir barely consumes 1 mA.

How to use the circuit

Readers should know by now how use the circuit, but just to make th clear: P2 serves to regulate the volu and P1 controls the treble. The turno point is altered by turning P1 fully a clockwise until it 'clicks' and b again. For each 'click' a lower turn



ure 1. The high boost control circuit for electric guitars. A single switch enables three different turnover points to be selected.



ure 2. The component overlay and the copper tracking pattern for the high boost printed cuit board.

Parts list

Resistors:
R1 = 47 k
R2,R7 = 22 k
R3,R4 = 1 M
R5,R6,R16 = 2M2
R8 = 27 k
R9,R14 = 100 k
R10,R11,R13,R15 = 470 k
R12 = 1 k
P1 = 220 k linear plus switch
P2 = 47 k log

Capacitors:
C1 = 47 n
C2 = 100 p
C3,C4 = 5n6
C5,C6,C11 = 10 n
C7 = 10 µ/16 V
C8 = 22 p
C10 = 1 µ/16 V

Semiconductors:
T1 = BC 549C
IC1 = 4013
IC2 = LM 308
IC3 = 4016

Miscellaneous:
S1 = sp switch (on P1)
S2 = sp switch

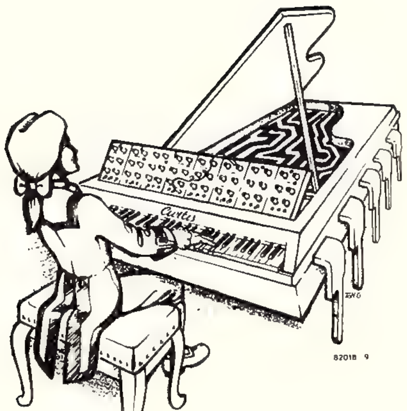
point is selected. Three operations are required to return to the original turnover point. The order of selection is high-middle-low. The first change will only be a very subtle alteration to the sound, whereas the lowest turnover frequency will give the greatest change. ◀

the new synthesizer

programmable and portable

The success of the Elektor Formant synthesiser led us to the opinion that there is a great interest among our readers in the field of electronic musical instruments, especially synthesisers. The availability of the new Curtis IC described in last month's issue prompted us to embark on an entirely new design.

Since the size of the Formant did not lend itself to portability it was decided that the new synthesiser should be truly portable without any lack in terms of performance. The new synthesiser is of modular construction and can be expanded into a polyphonic instrument with 'programming' facilities. This, the first article in the series, explains the basics behind the design.



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For some time our design team have been exploring the possibilities of a successor to the Formant, the Elektor synthesiser. Following the trend in technology, it was felt that a new concept was needed rather than just a rehash of a basic idea.

As regular readers know, the Curtis ICs have just recently made their appearance on this side of the water. These have been specifically designed for synthesisers and are probably the farthest that any company has dared to venture in terms of musical 'chips' so far. No further prompting was required to look into the possibilities of utilising these new ICs to form the basis of an entirely new synthesiser.

It was felt that a modern synthesiser should take on a new look together with simpler operation. This is the first article in a series describing a truly portable and fully operational instrument that can be constructed in modular form allowing expansion up to a polyphonic keyboard. Further it was decided that the ability to 'program' different sounds was a facility that could be extremely useful.

In this article we begin by discussing the fundamentals behind the new design.

Basically, the concept of the new synthesiser is that of a set of modules which could be combined in various ways leaving the reader free to build four different types of synthesisers using the same basic printed circuit boards. The possibilities are as follows:

1. a simple synthesiser
2. a simple synthesiser including a preset facility
3. a polyphonic synthesiser
4. a polyphonic synthesiser including a preset facility.

Throughout the series, readers will expected to be familiar with the stru ture and operation of synthesisers general. However, anyone who is ne to this rather complex field can find the basics in FORMANT Book One.

Why the preset facility?

You only have to analyse the synthet sounds used in Pop, Rock-and-Roll a Jazz to realize that the number different presets required is surprisin few. The audience recognizes t characteristic sound immediately, whi is why a lot of rock bands use o particular sound regularly as a kind 'label'. Furthermore, setting individu modules is extremely time-consumi and, on stage especially, this can be real nuisance. Things can be simplifi by providing a 'manual/preset' swit for all the elements required to produ a complex sound effect: filter f quencies, attack and decay times, V resonance factors, the interval betwe two VCOs or the envelope amplitu and so on. This is illustrated in figure where inputs 1 . . . 4 are for the pres control voltages.

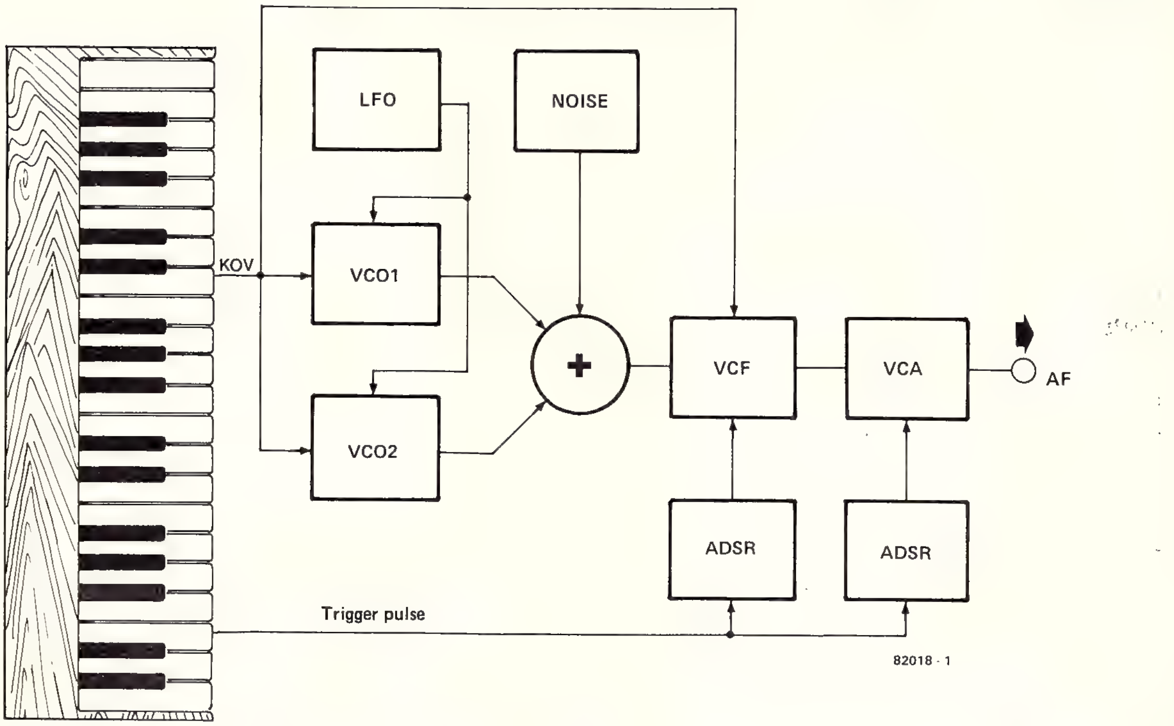
Since only very few variations regularly used in practice, they c easily be stored as 'programs' a 'called' when needed with the aid a single switch or a decimal keyboa If only four situations are required p parameter, say, it is not even necessa to store the exact control volta values in memory. CMOS analog switches can be used to select t desired voltages as shown in figure 3 in effect, this works like the rota switch shown in figure 3b. The on data that must be stored is the 'setti of the switches'.

Obviously, the possibility of full manu control by means of knobs on the fro panel must be maintained as an opti — if only for special effects.

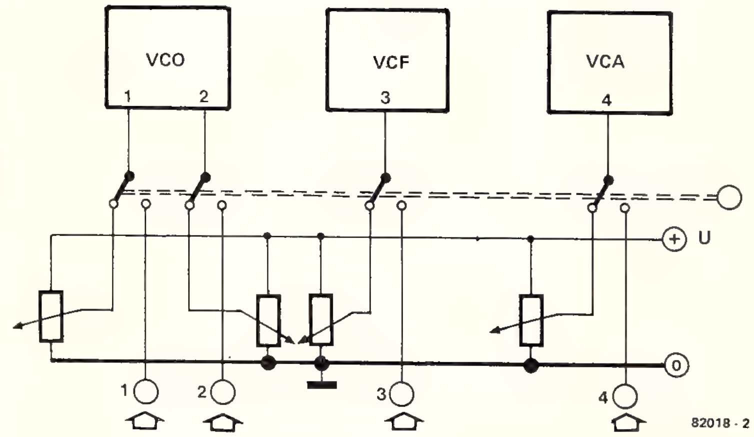
The individual boards belonging to t compact model do not need to modified if the circuit is provided wi a preset facility at a later date. T voltages which control the filter f quency, attack times, etc. are fed the corresponding modules in t compact model by way of the potenti meters on the front panel.

For the preset option, provision must made to break the connection from t front panel controls, as required, a drive the modules from some fix (preset) voltage instead. As mention above, CMOS switches are the obvio solution. For the VCOs, four differe preset voltages can be selected as sho in figure 3. The envelope wavefo from an ADSR module can be 'volta controlled' by passing it through a V (figure 4), and selecting any desi waveshape from the VCO output only slightly more complicated, illustrated in figure 5.

As can be seen, eight voltage controll switches are needed to select t



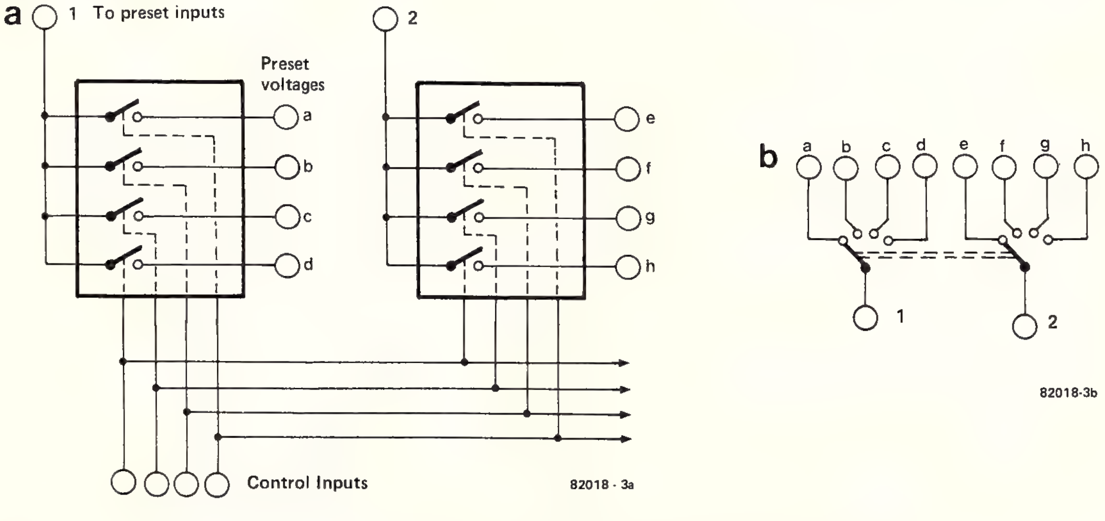
gure 1. A block diagram of the most straightforward version of the new synthesiser. Two VCOs, a VCF a VCA and two ADSR units are all that eeded for a 'bare-bones' system. With the addition of an LFO, which only produces a triangle signal, and a noise generator, a large number of ferent sounds can be achieved.



ure 2. The control inputs 1 . . . 4 on the various boards can either be linked to the wipers of potentiometers on the front panel or to external control voltage inputs.

waveforms (but if a 4066 is used, only 2 ICs are necessary). The principle is fairly straightforward. When the preset/manual switch S2 in figure 5 is in position A, S1' in IC2 will be closed. The waveform can now be selected with S1. Since the analogue switches in IC3 are switched 'off' when the manual/preset switch S2 is in position A, the data at the BCD inputs will have no effect on switches S2' . . . S4' in IC2. Resistors R6 . . . R10 make sure the switches are held fully 'off' when no voltage is applied to the control inputs. With S2 in position B, however, external data at the BCD inputs of IC3 will select the output waveshape.

As can be seen in figure 5, the octave 'range' switch and the fine tuning



ure 3. The circuit in figure 3a is little more than an electronic version of the rotary switch shown in figure 3b.

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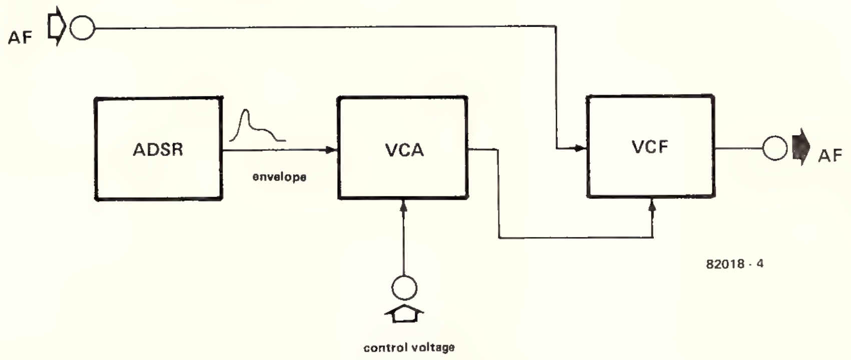

Figure 4. A VCA can be used to control the amplitude of the ADSR signal.

potentiometer are connected to th
VCO control input via IC4, in th
'manual' mode. When S2 is switched
'preset', the pre-programmed contr
voltage is selected instead.

Driving the preset inputs

Since the synthesiser is made up
individual modules it can be controlle
with the aid of external voltage
That's all very well, but how can this
put into practice? As an exampl
let's assume that sixteen preset voltag
are required for any given settin
Corresponding digital information c

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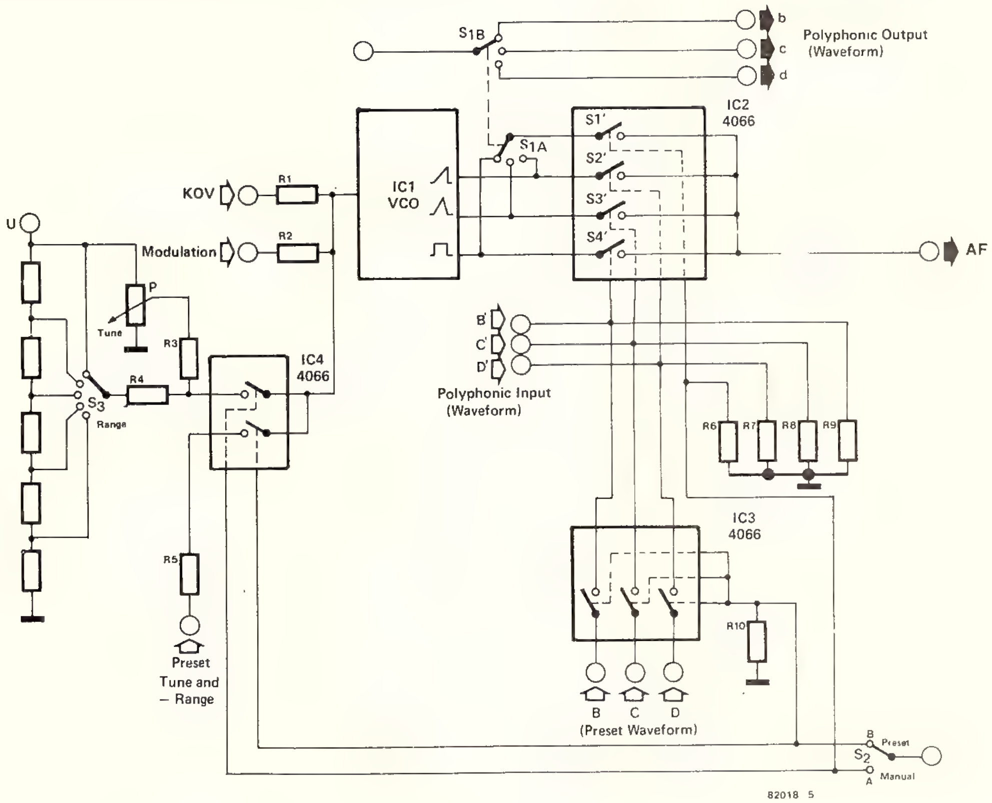

Figure 5. The complete VCO block diagram. The wiring of the CMOS switches gets rather complicated, since provision must be made for switching both the control voltage input and the output waveshape.

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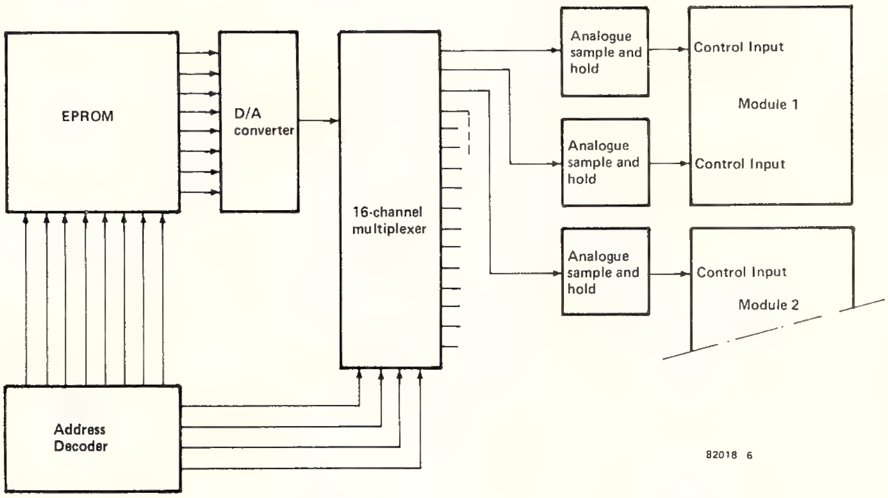
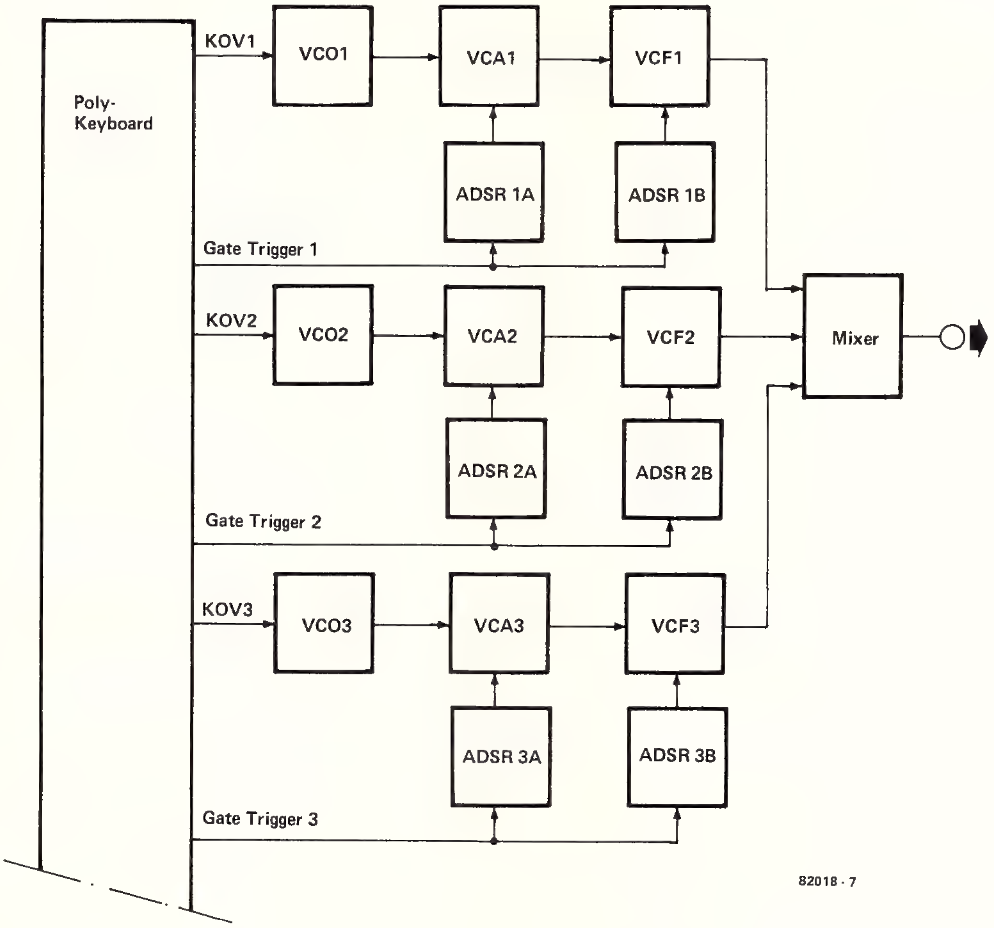


Figure 6. A simplified view of the preset circuit which can be included in an extended version of the synthesiser.



re 7. The block diagram of a polyphonic synthesiser. A polyphonic keyboard provides various control voltages (KOV) and gate pulses which control a complete unit (VCO, VCA, VCF and two envelope generators).

stored in EPROM, as shown in
re 6. The locations for any given
ing can be scanned in rapid suc-
sion and passed through a D/A
verter and 16-channel (analogue!)
tiplexer to sixteen sample-and-hold
ts. These, in turn, drive the control
ts of the various modules.

e polyphonic version

the polyphonic version (figure 7)
number of basic units required
ends on the number of keys that are
e played at the same time. Each key
to be provided with a VCO, a VCF,
CA and the corresponding envelope
erators. All the parameters are
trolled centrally either by the knobs
switches on the front panel or by
stored preset information. This
ans that when the synthesiser is
anded into a polyphonic instrument
re is no need to modify the front
el. This has the advantage that the
r does not have to buy everything at
e; instead, the monophonic unit can
extended by adding other boards. It
mportant however to have a poly-
nic keyboard with separate control
tage outputs. ■

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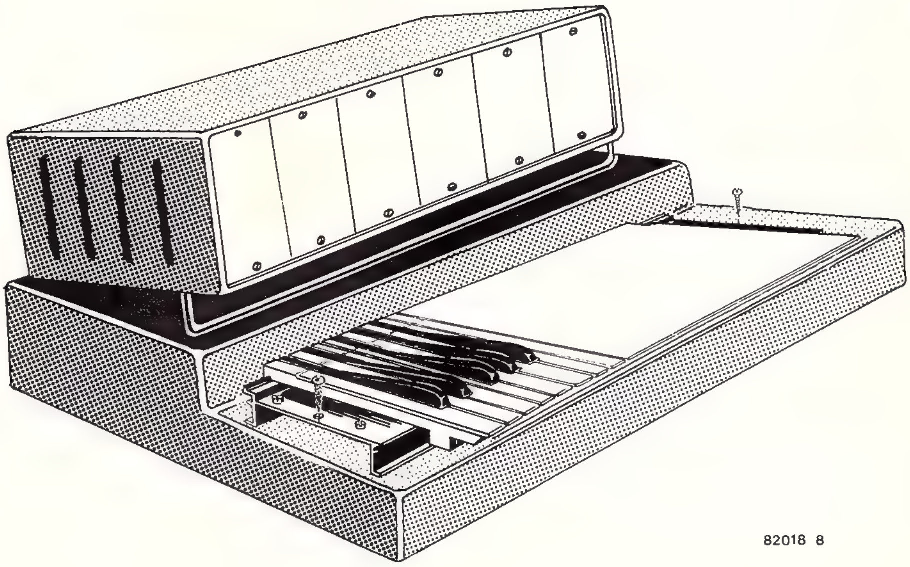


Figure 8. The compact synthesiser version can be housed in a small case and is truly portable. The expanded version will require a second case which is connected to the first by way of a multicore cable. For monophonic purposes the FORMANT keyboard can be used.

LCD frequency counter

professional appearance and performance

This is the first in a series of projects featuring a frequency counter module with a liquid crystal display. The high performance is out of all proportion to the simplicity of the circuit. Two switched ranges are available, the first up to 4 MHz for use in monitoring frequencies in microcomputers and the second up to a maximum of 35 MHz to cover CB transceivers and general use.
The complete counter and printed circuit board are housed in a hand held case that has been specifically designed for a module of this type.

The nice thing about our hobby is th
once in a while an electronic devi
comes along that just begs to be used
one way or another, and not just f
the original purpose that it was design
for. Just such a device in the neat litt
package from Thurlby Electronics, t
FM77T. This minor miracle is actual
a complete frequency counter modu
that includes a 4¾ digit LCD display,
measuring just 60 x 38 x 10 mm.
incorporates a CMOS LSI chip and
6.5536 MHz crystal oscillator and t
total will measure and display up
4 MHz with no external components.
As to be expected, we haven't stopp
at just a 4 MHz frequency counter
our use of the module. In fact this, t
first of the articles featuring this devic
incorporates a prescaler enabling
count frequency of up to 35 MHz
be achieved, and it is all mounted in
hand held case. We plan a furth
counter with a capability of 150 M
followed by a digital capacitance met
There are even more projects in t
pipeline but they must remain und
closed at the present time.

The counter module

Since the heart of the counter lies
the FM77T module it is interesting
see just what this package is capable
Besides being just a 4 MHz counter wi
a reading rate of 10 per second it c
also serve as digital frequency reado
for a radio or a tuner. It is possible
select any one of 26 preprogramm
standard IF offset frequencies. T
module can then be used to displ
the received frequency by measuri
the frequency of the local oscillator
the receiver.
The 3 decimal points are also selecta
together with the kHz, MHz and
legends at the right hand end of t
display. Two other inputs are of i
portance, both requiring a high le
(supply level) to activate. One is
'hold' input which freezes the displ
and the other is a 'reset' input whi
will return the display to zero.
The maximum display is in fact 399
but the counter will overflow, in whi
case the correct reading will be t
display minus 40 000. Thus 5,9 M
will be displayed as 1.9 MHz. T
module will operate on supply volta
between 4.75 V and 7 V with a typi
power consumption of a little o
1 mA. A word of warning here, parti
lar care must be taken to prevent
correct connection of the power sup
because this will convert the mod
to an expensive inmate of the rubb
bin.

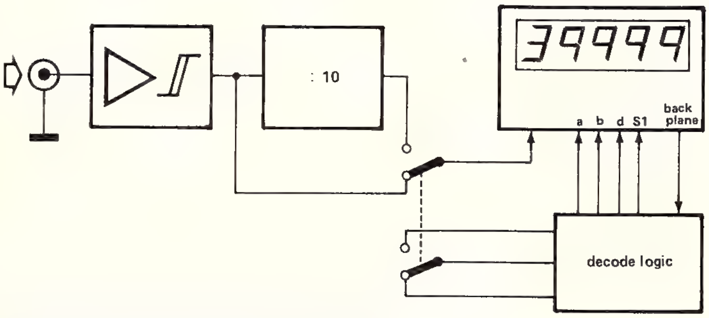
The basic frequency counter

The first in the series of projects i
hand held frequency counter havi
two ranges, 4 MHz and 35 MHz (40 M
if you really push it!). The spec
cations are given in table 1 and they
very good, especially when the to

le 1

Specification of the frequency counter:

Frequency range 1: 2 kHz . . . 3.999 MHz
input sensitivity: 30 mV RMS
Frequency range 2: 100 kHz . . . 39.999 MHz
input sensitivity: 80 mV RMS, 100 kHz . . . 20 MHz
150 mV RMS, 20 MHz . . . 30 MHz
450 mV RMS, 30 MHz . . . 35 MHz
900 mV RMS, 35 MHz . . . 40 MHz
Maximum input voltage: 50 V RMS
Input impedance: 1 MΩ/10 pF for U_{in} < 700 mV
Calibration: none required
Power supply: 9 V battery or NICAD or external 8 . . . 12 V AC power/charging source
Current consumption: 40 mA max.
Automatic decimal point shift
Automatic kHz or MHz display



ure 1. The block diagram of the frequency counter.

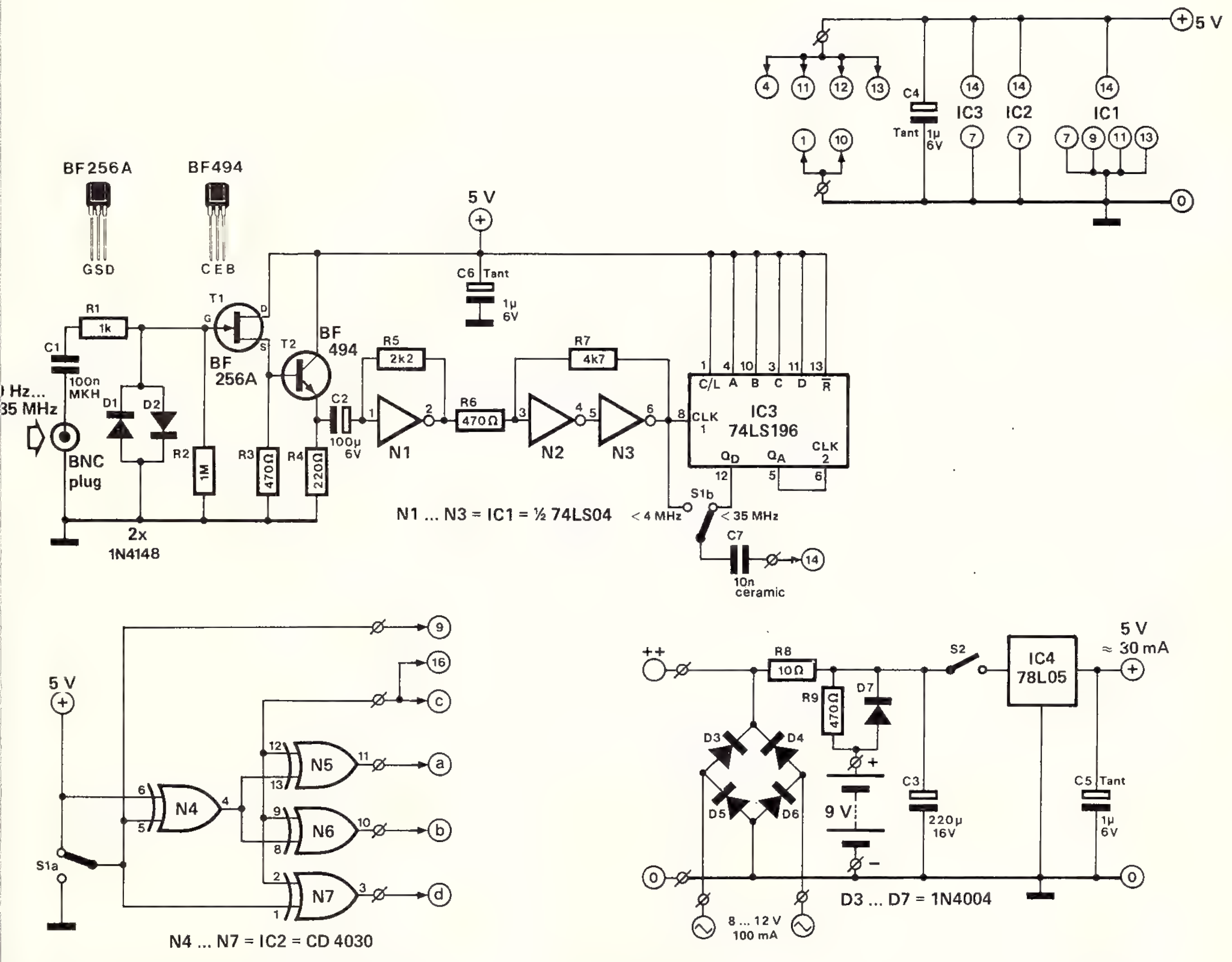
cost of the counter is taken into consideration. Probably the most notable point is that the input level can be anywhere between 30 mV and 50 V without fear of damage occuring.

Block diagram

The simplicity of the counter will be apparent from the block diagram shown in figure 1. The input amplifier is followed by the divide-by-ten prescaler to produce a maximum count of better than 35 MHz. The divider can be bypassed with the aid of a switch to obtain a maximum count of 3999.9 kHz. The automatic decimal point and legend display is controlled by the lower block in the diagram.

The circuit

Only a very few components are required as can be seen from the circuit diagram in figure 2. The two diodes D1 and D2 are to protect the circuit from excessively high input levels (50 V is an absolute maximum). T1 and T2 together form a 'super source follower' or impedance converter and will convert the high (1 MΩ) input impedance to about 220 Ω for the amplifier N1. The amplifier is in fact a TTL inverter but its output will still be analogue for



ure 2. The high performance of the frequency counter is out of proportion to the simple circuit diagram shown here. The numbers in circles te to connection points on the module in figure 3.

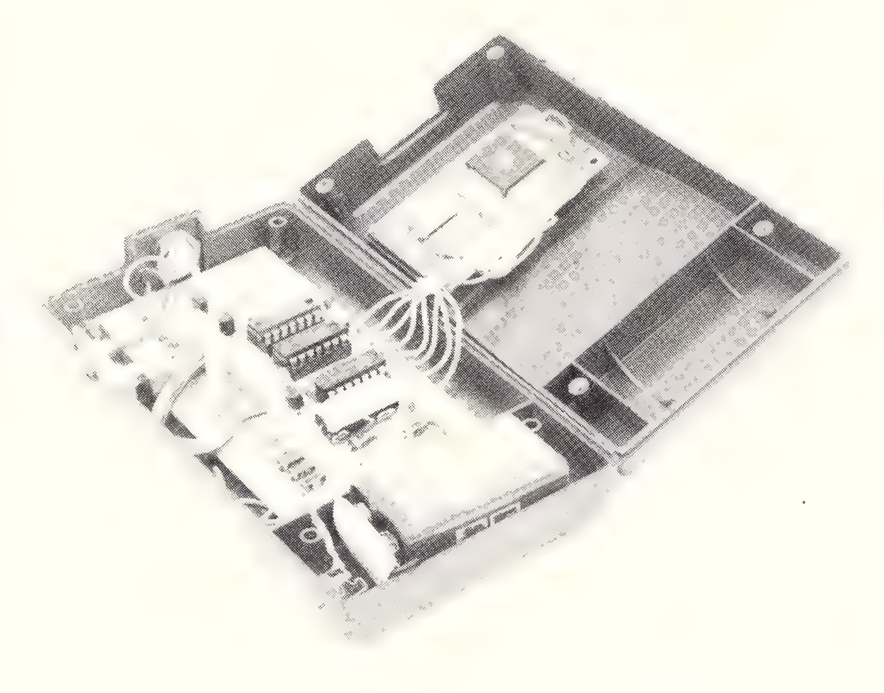


Photo illustration. The counter printed circuit board and module have been designed to fit the Vero 65-2996H case.

3

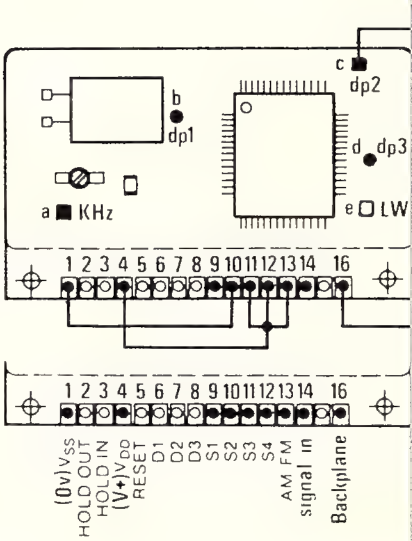


Figure 3. The frequency counter module is illustrated here. The links shown must be made during construction.

4

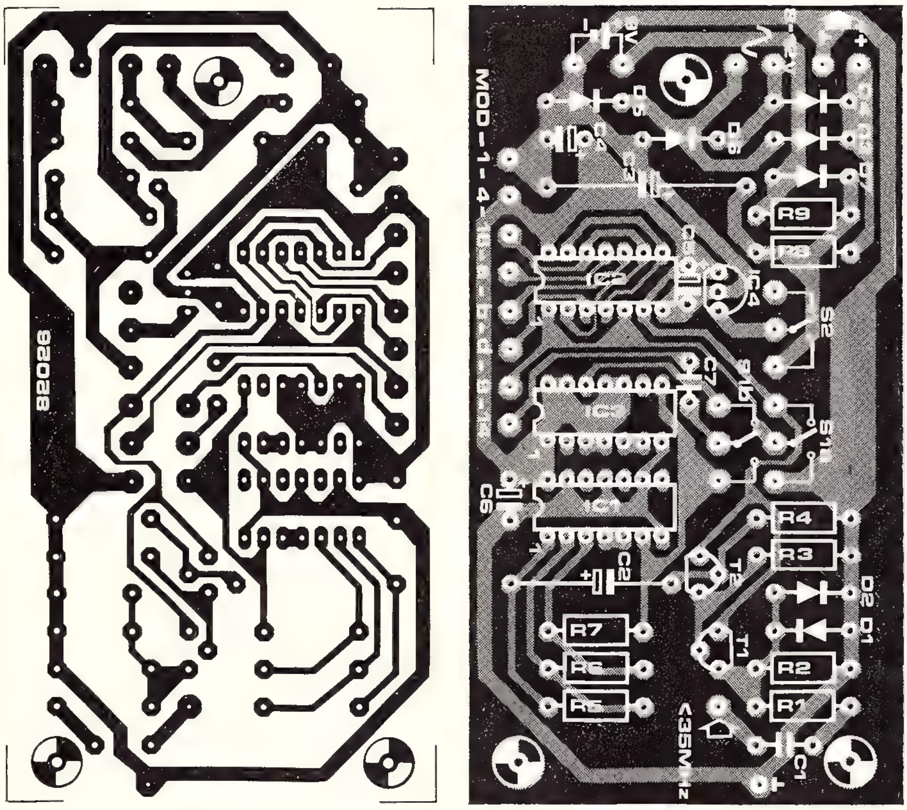


Figure 4. The track pattern and component layout for the printed circuit board of the counter.

Parts list

Resistors:
R1 = 1 k
R2 = 1 M
R3,R6,R9 = 470 Ω
R5 = 2k2
R7 = 4k7
R8 = 10 Ω

Capacitors:
C1 = 100 n MKH
C2 = 100 μ/6 V
C3 = 220 μ/16 V
C4 . . . C6 = 1 μ/6 V tantalum
C7 = 10 μ ceramic

Semiconductors:
T1 = BF 256A (not B or C)
T2 = BF 494
IC1 = 74LS04
IC2 = 4030
IC3 = 74LS196
IC4 = 78L05
D1,D2 = 1N4148
D3 . . . D7 = 1N4004

Miscellaneous:
S1 = DPDT miniature switch
S2 = SPDT miniature switch
battery = PP9 or NICAD equivalent
Hand held case = 65-2996H from Vero Electronics Limited
Module = FM77T from Thurlby Electronics Limited, Coach Mews, St. Ives, Huntingdo Cambridgeshire.

small input voltages. At pin 2 it will be between 1.5 V and 1.8 V peak to peak for an input voltage at C1 of 30 mV RMS. The analogue waveform is converted to digital by the pulse shaping circuit formed by N2 and N3. Next in the chain of events is a divide-by-ten IC3, which can be switched in or out of the circuit depending on the position of S1.

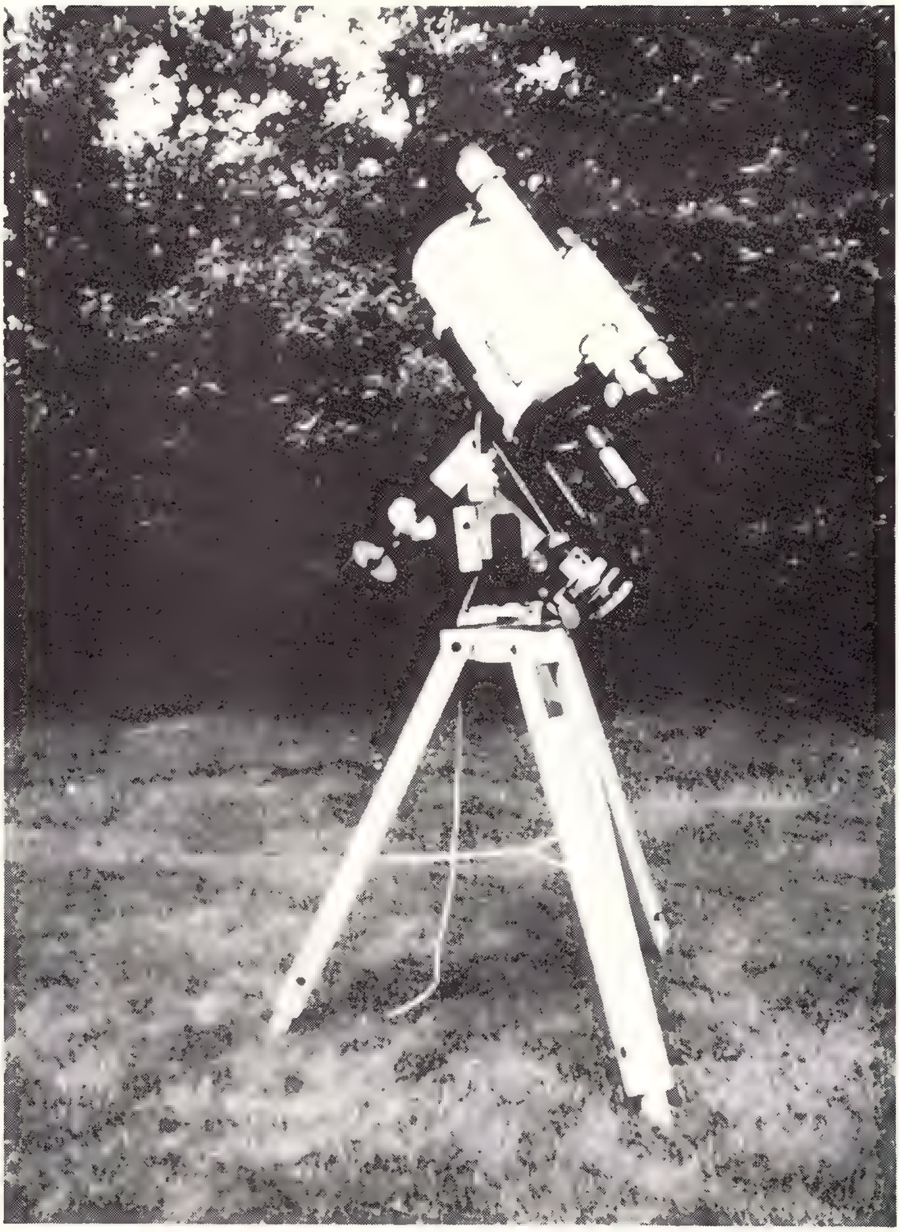
The remaining gates N4 . . . N7 are used purely as a decoding circuit to determine the position of the decim point and the legend (MHz or kH again depending on the position of S1.

The power supply for the counter slightly more complex since four supp options are possible. A standard 78L(

ulator is used as the maximum
rrent consumption for the entire
unter is not more than 30 mA. In
e first *case*, power can be provided by
ordinary PP9 dry battery which will
e approximately six hours of contin-
l operation. Resistor R9 will not be
eded. If on the other hand the PP9
to be replaced with a NICAD, R9 will
required since this provides a path
the NICAD charging current when
e counter is supplied with an external
. . 12 V AC source. The value of R9
dependant on the NICAD used and
ıst be calculated to provide a charge
rrent of 20 . . . 25 mA when the
CAD is discharged. Resistor R8 acts
a limiting resistor to prevent excessive
sipation in the regulator. The final
tion is an external DC power source
d this will appear in greater detail in a
ure article.

onstruction

ving said all there is to say about the
atively simple circuit we can move
to construction. The case used for
is project is the hand held box from
ro, part number 65-2996H. The point
bear in mind is that the interior of
e case will become fairly full therefore
would make sense to assemble and
nnect the component parts of the
unter together as far as possible
fore mounting the whole into the
se. Ribbon cable will be ideal but
ve enough length to allow assembly,
rticularly between the module and
e printed circuit board. It should be
membered that the case is plastic and
therefore defenceless against a sudden
ack by a hot soldering iron.
this stage it will be as well to double
eck that all wiring is correct (in-
ding the battery connector).
e two switches can be mounted in a
all piece of circuit board material
at is fixed with super glue to the
ide of the lower half of the case.
ke care to space them apart enough
allow them to fit side by side. The
odule can also be fixed in place with
o or three drops of super glue. Only
very small amount will be sufficient.
e printed circuit board can now be
ounted using three very short screws.
e BNC socket can be fitted last of
and making this connection is the
ly soldering that needs to be carried
t inside the case. The miniature
cket for the external AC power source
n be mounted at one end of the
ttery compartment.
fore finally closing the case, ensure
at connecting wires can not become
pped between the two halves of the
se. If satisfied that all is as it should
a power source can now be con-
cted to check the operation of the
unter. There is no calibration required
erefore the reading will be correct
ht from the start. ◀



telescope control

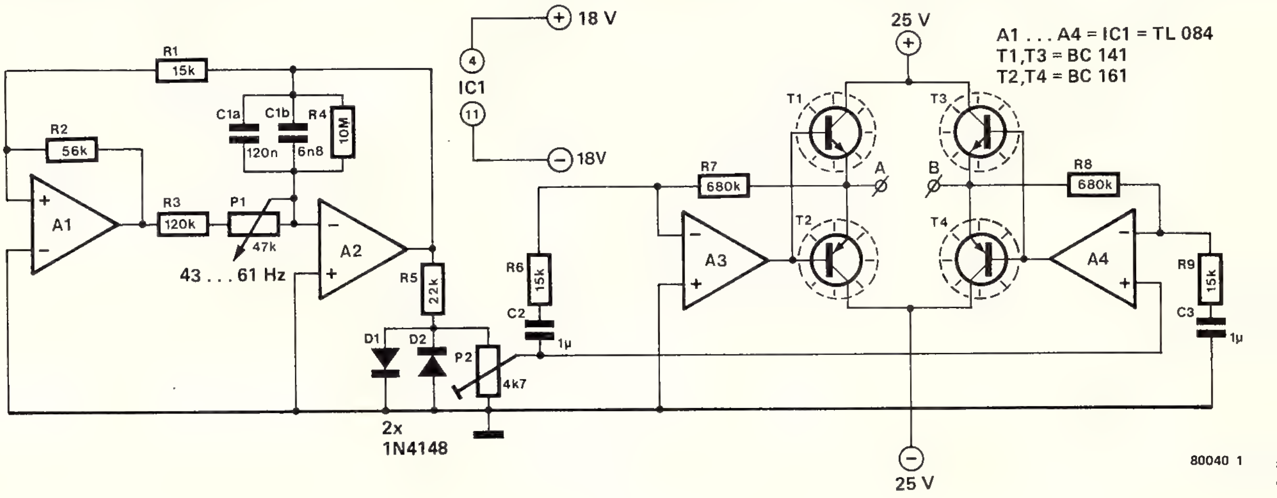
seeing distant stars . . .

Stopping the movement of heavenly bodies (on a photographic plate at least) is the purpose of this article. A camera mounted on a telescope can, with a long enough time exposure, enable the more distant stars to be observed. To do this the telescope must be able to track the star accurately for the period of the exposure. Two 24 V synchronous motors are used to enable the telescope to traverse at an accurate speed in either direction.

An important part of astronomy is of course observing stars and other heavenly bodies. Observations can be carried out with the aid of a telescope or even, in some instances, with the naked eye. A vast number of stars still remain unseen however and in order to study them, somehow these (or some of them at least) must be made visible. The method of doing this is to take a photograph of them through a telescope but in order to be any good it must be a time exposure.

Exposure times varying from some minutes or even hours are necessary for the very distant stars to become visible on film and this can cause some problems. During a fairly long exposure the 'position' of the star will change due to the rotation of the earth and the result on the film will not be a dot but a dash.

1



Since halting the rotation of the earth is a little beyond the scope of this particular article we will have to deal with the problem in a simpler manner.

Following a star with the telescope can obviously not be done by hand if a clear image on the film is to be obtained. The movement will have to be so small and carried out so slowly that any star-watcher would probably revert to stamp collecting before sunrise. The answer is of course a motor drive.

Motor drive

For a motor drive to operate precisely a synchronous motor is an obvious choice. An electric clock motor could well spring to mind since the movement of the telescope can be compared with the hour hand of a clock. However, a clock motor will invariably be too weak and therefore, either a motor specifically designed to drive telescopes or a motor and gearbox combination must be used. It must be a synchronous motor because the speed of this type of motor is directly dependent on the frequency of the AC supply that powers it.

Almost all synchronous motors available in the U.K. have been designed for use with a frequency of 50 Hz. This provides them with a very stable speed, exactly what we want for our purposes — nice and simple! Unfortunately *not*, there is a snag. Yes, the motor speed should be constant but it must also be accurately adjustable within certain limits. This is necessary because the so called 'astronomic day' isn't exactly equal to our common or garden 'earthly day' of 24 hours, but slightly shorter. Moreover the length depends on the seasonal 'wobble' of the earth. We are currently working on an article to rectify this using PLL (Planet Locked Loop). The AC supply used to drive the synchronous motor must therefore be finely adjustable. This article provides the circuit for just such a variable frequency AC power supply designed for 24 V 50 Hz motors.

The AC generator

The circuit diagram for the AC generator is shown in figure 1. The two opamps A1 and A2 together form a triangular waveform generator. This waveform is 'rounded off' by R5 a the two diodes D1 and D2 because synchronous motor prefers a mo sinusoidal supply.

The frequency of the generator adjustable between approximately and 61 Hz via P1. The preset pote tiometer P2 is used to adjust the outp amplitude of the bridge amplifier.

A bridge configuration is used becau it is able to produce an output amp tude of twice the supply voltage lev In this case, the amplified AC volta between the points A and B has a pe value of 32 V. This results in an RM value that is fractionally lower than t desired 24 V that is needed to drive t motor.

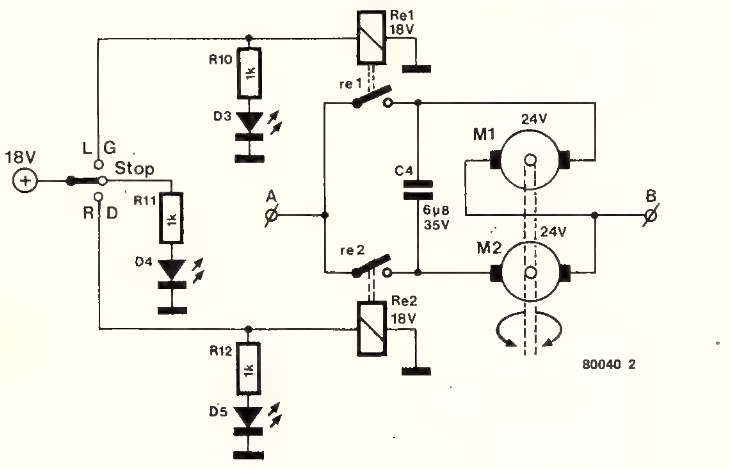
Left and right

To be practical, the telescope must able to turn in both directions enable it to track any star in any p ition. Synchronous motors however v only drive in one direction, they are r reversible. The simple answer to this to provide the drive with two mot arranged to drive in opposite directio on one shaft. If one of the motors now supplied with power, the other v just free-wheel backwards.

The drawing in figure 2 illustrates h power is supplied to each motor. T points A and B in this drawing cor spond to points A and B in figure 1. T two relays Re1 and Re2 are controll by the three position switch (left, sto right). Motor M1 is switched on by R and motor M2 by Re2. The switch a relays are arranged in this manner enable the two motors to be controll remotely which may well be desiral to prevent vibration of the telescope.

Since movement of the telescope will very slow, the LED's have been includ to give an indication of direction, if ar The capacitor C4 must be unpolarise that is, an electrolytic will not do. T control electronics require a stabilis supply of 18 V while the power sta T1 . . . T4 can be connected to unstabilised 24 V DC source.

2



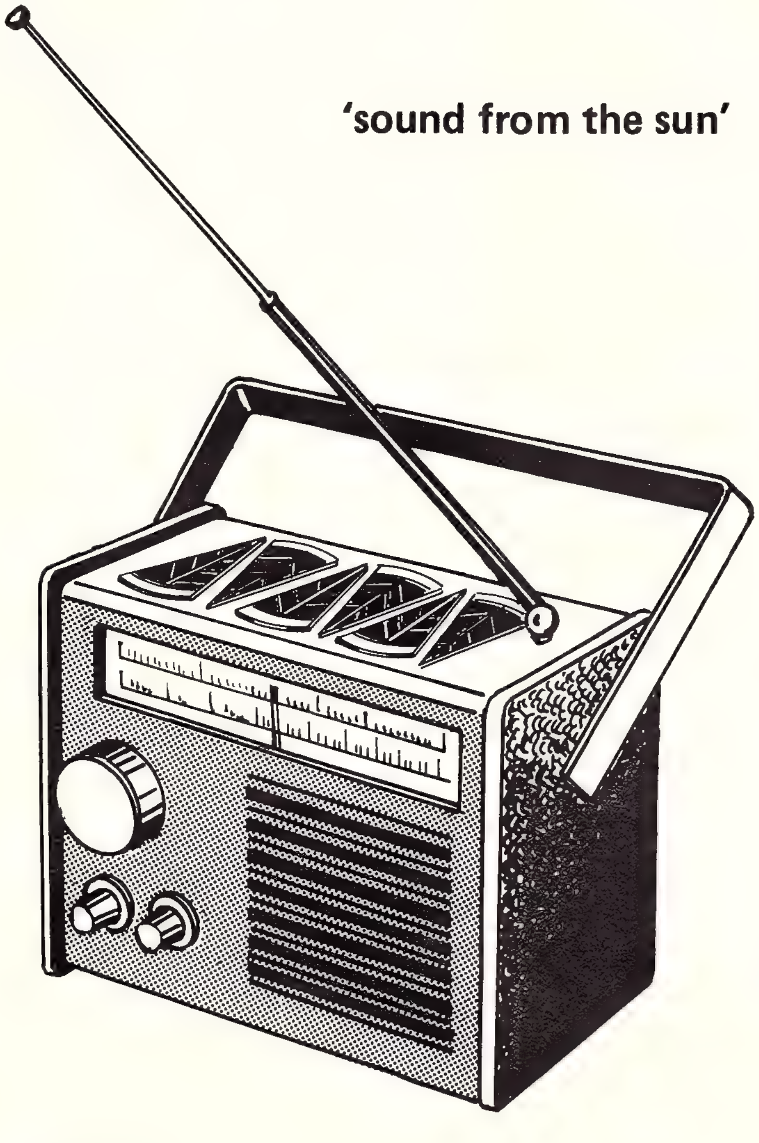
solar powered receiver

he sky's the limit as far as fuel costs are concerned and, like Atlas, we e all finding it increasingly difficult to shoulder the burden. One nsolation: when Earth's resources are finally depleted, we will still be le to turn to the Mother of all energy, the sun.

owly but surely, solar cells are at last coming down in price, so that ne of these days 'sun-powered' radios, kitchen equipment, heating stems, etc. are going to be economically viable.

evelopments in technology have always fascinated hobbyists and ientists alike and readers are invited to participate in an experiment nd build a solar powered receiver.

'sound from the sun'



The need to save energy has become a daily part of our lives, not least because of the huge publicity given to it. The media are really going to town and so is the government, what with the advertisement campaigns on television, radio and in the newspapers. The effects are sometimes quite astonishing. The notion 'room temperature', for instance, seems to have dropped to a sub-zero level. People are reluctant to open the curtains in the morning for fear of losing precious warmth.

Contrary to what might be expected, the result is a vicious circle. For now that less energy is being consumed, gas and electricity companies are losing money and are therefore forced to put up their rates. The consumers then react by 'tightening the belt' even further, so that the prices go up again . . . etc. . . . etc.

The fact remains: the world's resources are being exhausted and at an alarming rate. There's only one thing for it, new substitutes will have to be found. One of the main alternatives currently being tried out on a large scale is solar energy. Developments have not yet reached the stage where the 'big' domestic appliances, such as washing machines and central heating systems, can be powered with solar energy, but the 'small' ones can and this also includes radios. The design described here provides a low-cost portable receiver that can be powered with surprisingly few solar cells.

Low power

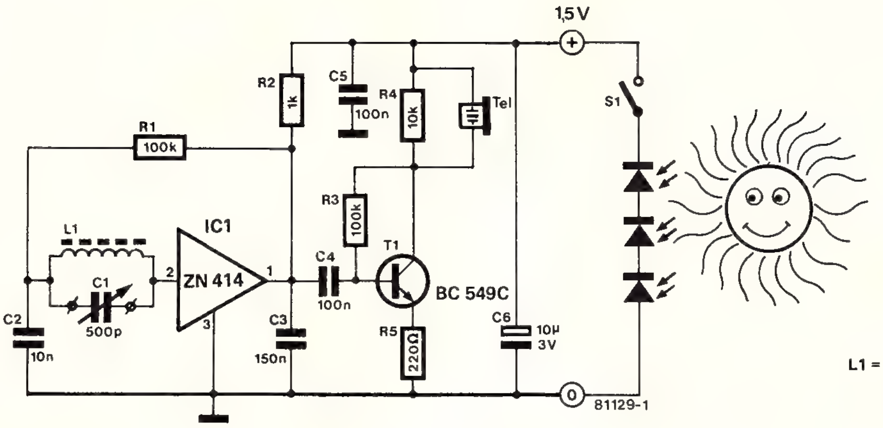
Solar cells are now readily available in all sorts of shapes and sizes, although the smaller kind tend to be triangular. It is unfortunate that the really effective ones are very expensive. What's more, each cell can only generate about 0.5 . . . 0.6 volts, which must be taken into account when designing a solar powered receiver.

The circuit's current consumption and power supply voltage will therefore both have to be very low.

One design that goes a long way towards meeting these requirements is the medium wave receiver published in March (Elektor 71, p. 3-32). This receiver already has a current consumption low enough for it to be powered with solar energy. Unfortunately, however, the audio amplifier in the circuit requires a rather high supply voltage, which means an awful lot of solar cells would have to be connected in series for it to work!

Let's forget about the audio amplifier for the moment and look at the receiver section. The prospects here are much more favourable. The ZN 414 IC from Ferranti which is at the heart of the receiver fits the bill perfectly. The IC's supply voltage range is between 1.2 and 1.6 volts and only requires 0.3 mA. In other words, two or three tiny solar cells are all that is needed.

1



L1 = 48 turns of 0.3 mm diameter enamelled copper wire on a ferrite rod of 10 mm diameter 10 cm long

Figure 1. A solar cell receiver design for beginners. The circuit includes a ZN 414 IC, a single transistor that acts as an audio amplifier and a high impedance crystal ear-phone.

Figure 1 shows a simplified version of the MW receiver which includes an ear-phone. Its current consumption is very low (less than 0.5 mA) and even on an overcast day the circuit provides a reasonable reception using the cheaper kind of solar cells. Provided three cells are used which, when combined together, produce about 1.5 . . . 1.6 V, the components may have the values indicated in figure 1. If the output of the cells reaches as high as 0.6 volts each, the third one may be omitted — only then it is advisable to lower the resistance of R2 to 470 Ω. The ear-phones must be high impedance crystal types, as otherwise T1 will be overloaded and the receiver will not function.

As can be seen from figure 1, this MW set needs very few components and yet it leads to a fully 'self-sufficient' radio.

Medium and short wave superhet

Obviously, a set that is run on only two or three solar cells is bound to have a flaw somewhere. You can hardly expect to drive a first-class receiver on a power supply of 1.5 V!

Readers who are prepared to dig a little deeper into their pockets and buy six cells can build a much better design that only requires a supply of 3 volts. The prototype constructed at Elektor did in fact look (and sound!) very promising. The circuit diagram is shown in figure 2. The receiver covers one medium wave band and two short wave bands. The first of the latter extends from 1.7 to 5.1 MHz and includes the popular 'fishermen's' frequency range. The second range is situated between about 5.1 and 15 MHz, and includes the 49 metre band (= at around 6 MHz). The prototype had a sensitivity of about 2 μV.

What kind of receiver is it? Well, basically, it is an ordinary superheterodyne with a few tricks here and there in the circuit to ensure low power operation with a minimum current consumption. Provided the volume is not turned too high, the whole receiver should not need more than 5 or 6 mA — which could get the circuit mentioned in the Guinness Book of Records!

Now let us take a closer look at figure 2. First of all, the audio amplifier. Regular readers will recognise it to be the 'ulp amp' published in last year's Summer Circuits' issue (circuit no. 55). The amplifier is constructed with ordinary transistors and operates at any supply voltage level between 3 and 12 volts. It will produce about 100 mW maximum power. The design of the output stage, which has no quiescent current adjustment, ensures that current consumption is extremely low (1.5 mA) which makes it eminently suitable for the solar cell power supply.

Now what about the actual receiver section?

The power supply voltage here is stabilised in the circuit around T6 . . . T8. Again, any voltage between 3 and 12 volts may be applied. Transistor T1 amplifies the RF input signal and S2 allows the tuned circuit to be switched from one frequency range to another. The local oscillator is built up around T3 and T4 and can, of course, be switched between the three frequency ranges with the aid of the same switch (S2b). Transistor T2 mixes the oscillator and the input signals, after which the 455 kHz IF signal is filtered by means of a ceramic filter (Toko CFM 2 - 455 A). The IF signal is then amplified and demodulated inside the ZN 414.

Time to go into a few more details.

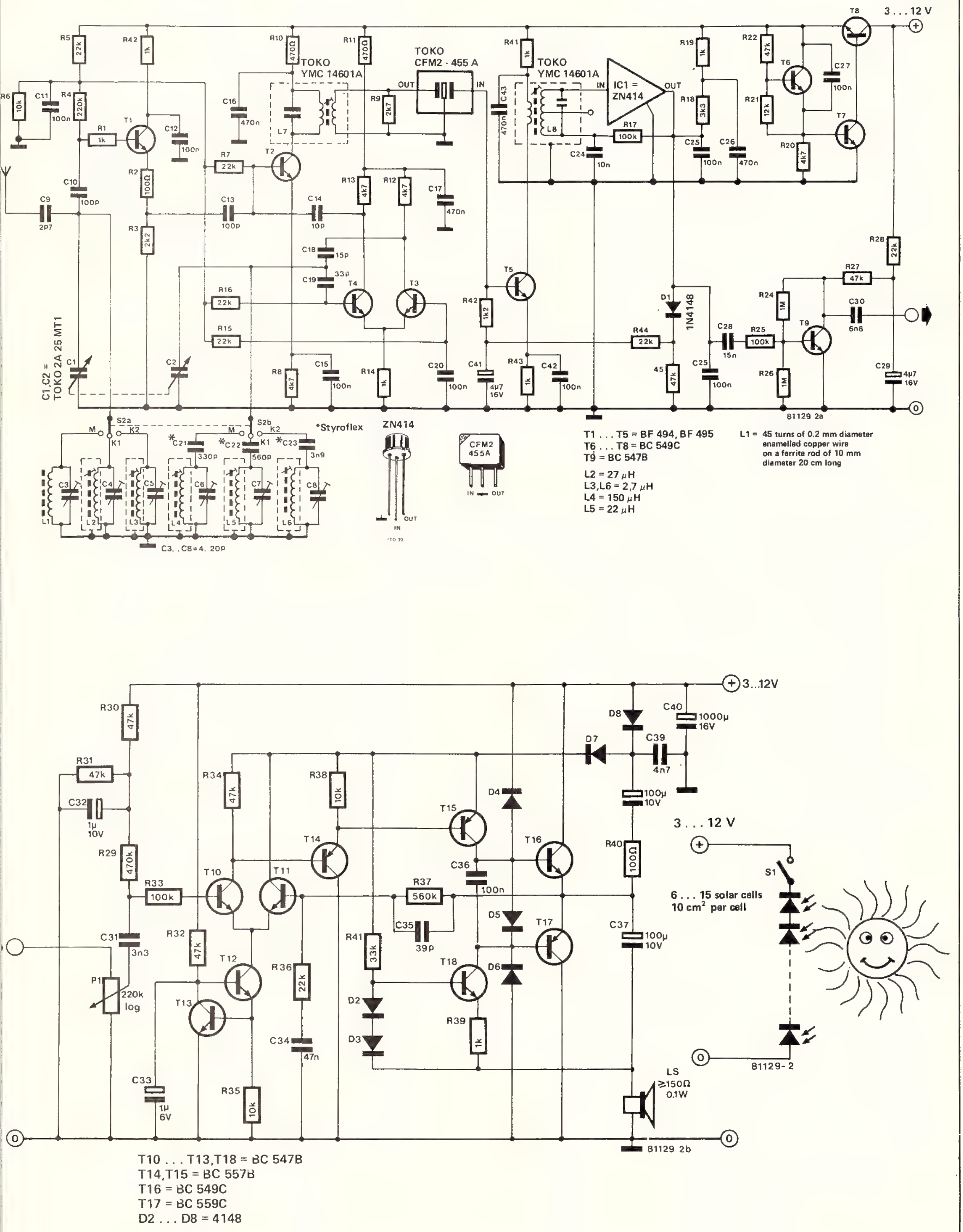
The RF amplifier T1 is an ordinary amplifier stage which is biassed at an unusually low level. There's nothing extraordinary about the oscillator T T4, except that it is not usually cluded in receivers at this particu spot. The design selected is fai reliable at the low supply voltage a yet capable of producing a sufficien powerful oscillator signal. This oscilla has the added advantage that it or requires a single pole switch to sel the various frequency ranges. The os lator coils (L4 . . . L6) do not have ta The mixing stage T2 and the filt following it are quite straightforward.

As for IC1, this was discussed in dep in the article on the MW receiver pu lished in March. Since the IC used, t ZN 414, consumes very little curre there was no need to look for a mo economical component. Its automa gain control, however, has been adapt to suit the more serious nature of t present design. After all, the solar c receiver needs to be of a much high quality than its MW counterpart (whic remember, was meant to teach buddi electronics enthusiasts how to bu thier first radio!) and the straightfo ward version shown in figure 1.

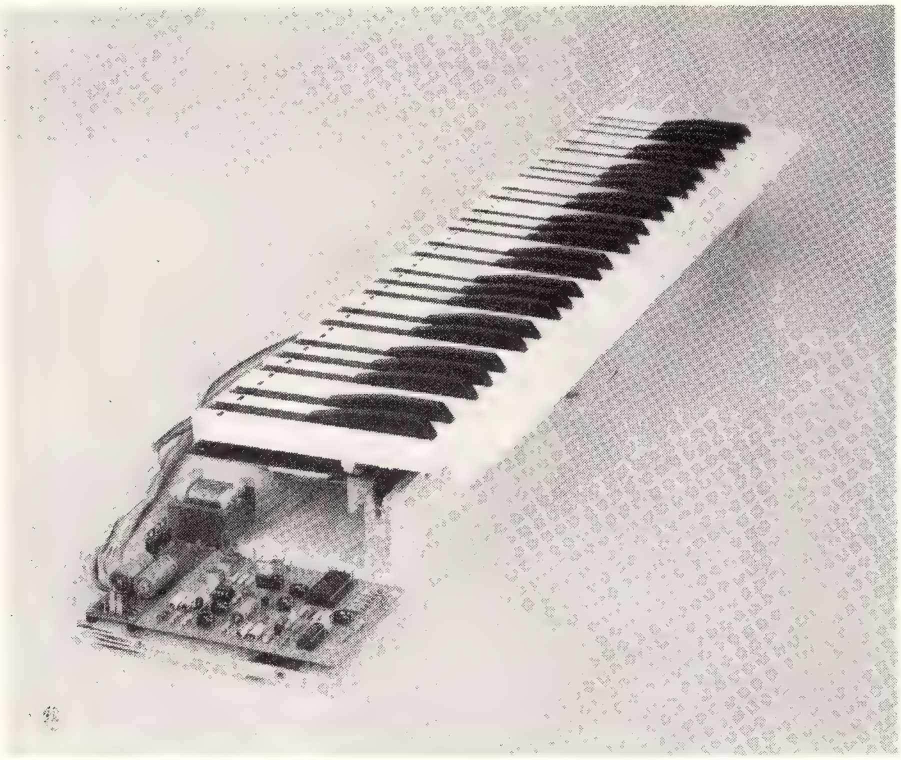
Normally speaking, the AGC's ran would only be about 20 dB which certainly not enough for a good receiv This is remedied by deriving an a ditional control voltage from the outp of IC1 by way of D1, R44 and R45, a result of which T5 will be 'cut off', th is to say, it will stop conducting, in t presence of powerful signals. Thanks this modification the AGC now has very reasonable range of about 50 dB.

All in all, the circuit is very cost-effect and although it looks rather comp cated at first it should be easy enou to build. The only really expensi items are of course the solar cells, b rumour has it that in the near futu these too will be available at a mu lower cost.

2



gure 2. A sophisticated triple wave band receiver which can be powered with solar cells. Inspite of the large number of transistors used, current nsumption will only be about 5 mA.



the mini organ

musical fun and games on a single chip

Building an electronic organ from scratch can be a tedious and expensive business costing anything over £ 200 and several weeks of hard work. Now for the good news: this particular organ incorporates all the electronics needed on a single compact board and can be built in a matter of hours. Thanks to ITT's special 'organ IC', the mini organ is highly economical and provides a remarkably good performance (that is, as long as the organist isn't 'all thumbs''!). Fun for everyone . . . at the price of a single chip.

ITT recently introduced the high
interesting SAA 1900 IC which, th
company claims, is the 'key' to a cor
plete organ. The data sheets, howeve
are a little ambiguous about the chip
possibilities. On the one hand, they pr
vide a great many fascinating technic
specifications, but on the other han
they modestly christen their brai
child a 'One Chip Toy Organ IC'! Th
article intends to discover whether th
IC is in fact just another 'toy',
whether it can be recommended f
serious musical instruments as we
And the best way to find out is,
course, to get hold of such an IC ar
test it.

As readers can gather from the headin
the test not only proved successful, o
designers had so much fun that the
was up-graded from 'Toy Organ'
'Mini Organ'!

The SAA 1900

The IC includes a keyboard scanni
facility. This scans the 56 single k
contacts, 37 of which belong to th
'solo' keyboard and 19 of which cons
tute the 'accompaniment' manual. It
fully polyphonic with separate outpu
for CHORD and BASS. These are co
trolled by the accompaniment sectio
In addition, there are two separate voi

1

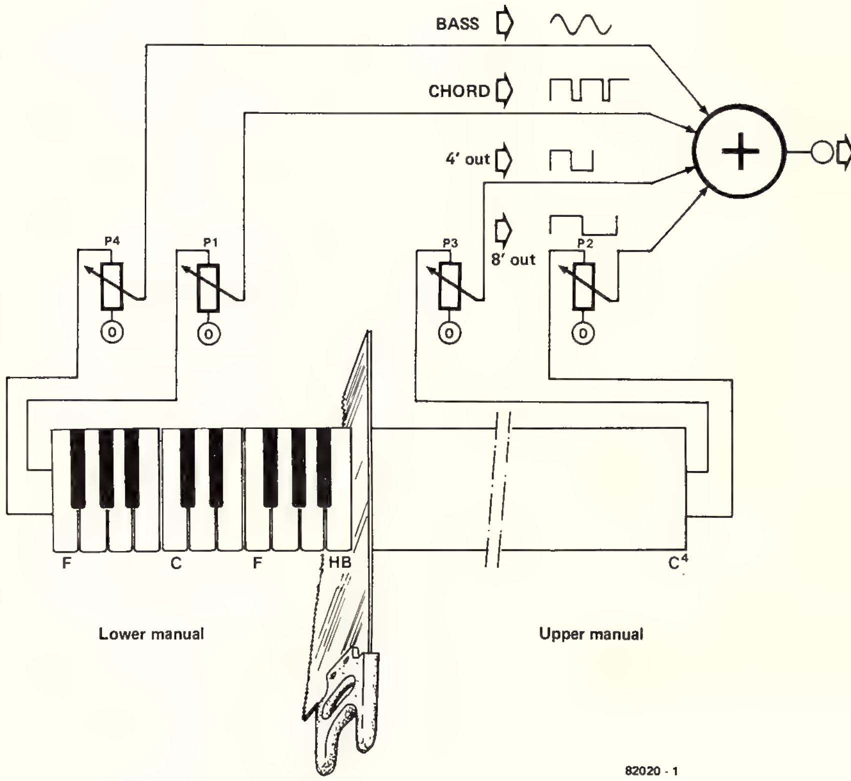
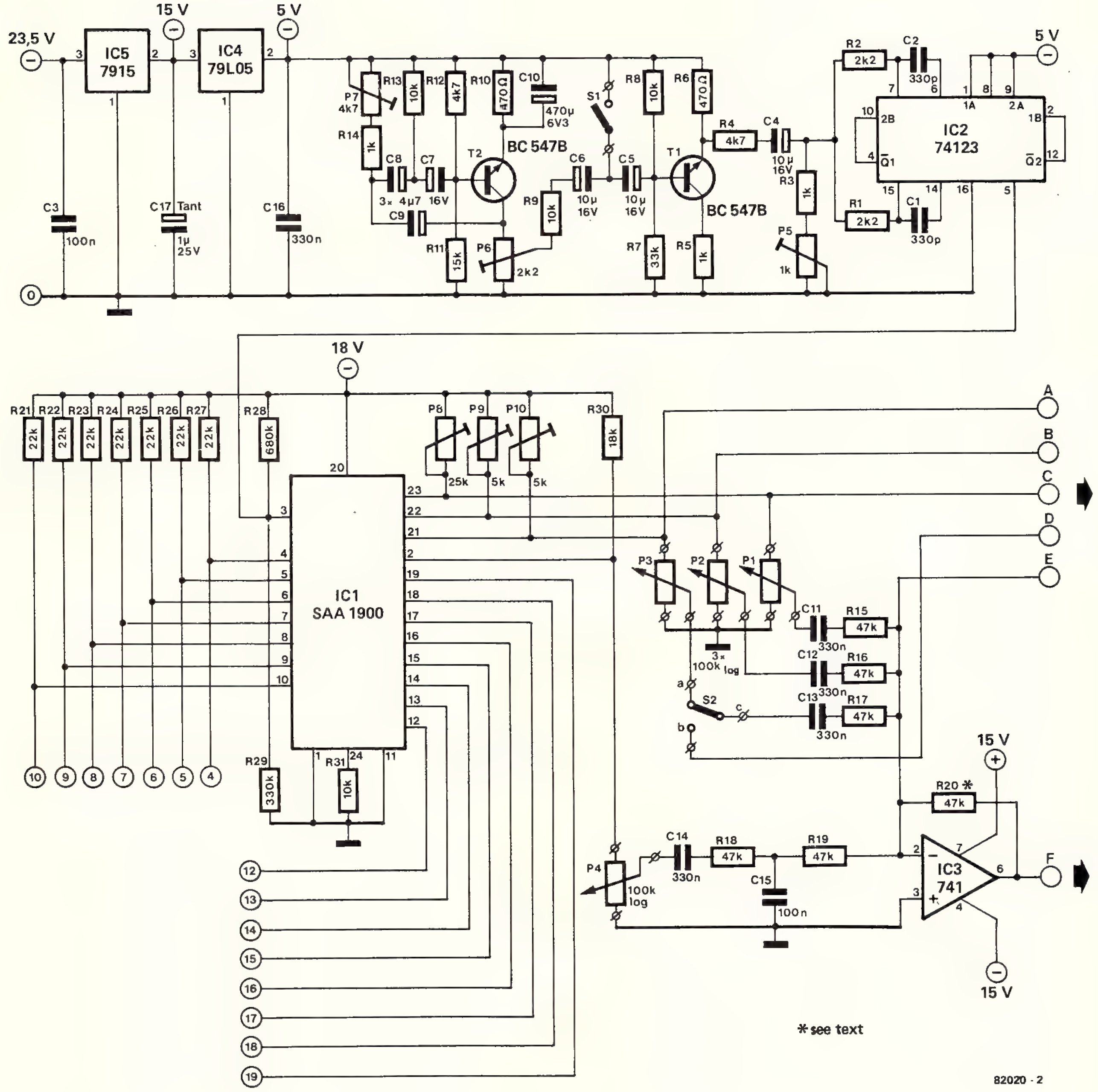


Figure 1. The SAA 1900 IC produces four separate LF output signals which are mixed at the output. A signal will only be available at the BASS and CHORD outputs, provided one (or several) of the lower 19 keys is (are) depressed. The "4'out" and "8'out" outputs can only be modulated by the remaining keys. The BASS output is monophonic: only the lowest note of a chord is heard.



igure 2. The complete organ circuit diagram is made up of four sections: an organ IC, a clock oscillator, a modulation oscillator (vibrato) and a ixing stage. Whereas the external components are all familiar types, the 56 dot scanner matrix belonging to the SAA 1900 is something of a ovelty. It makes wiring a lot easier.

utputs, 4' and 8', controlled by the 'olo' part of the keyboard.

hereas the 37 upper keys provide the elody manual, the 19 lower ones are sed for the left-hand accompaniment. y 'accompaniment', something more is eant than the usual 'one-finger' technique. Instead, genuine polyphonic keys re available, so that the organist is free o invent chords. Furthermore, the ccompaniment manual has its own output, enabling the volume of the left- and backing to be adjusted independently from that of the melody on the solo section. This set-up is very practical and offers the advantages of a church organ, where a set of stops allows for a variety of volume — and manual — combinations.

With only 19 keys, the accompaniment manual's possibilities are rather limited. After playing a few chords 'up the scale' the player will run out of notes and inadvertently striking a solo key will lead to a jarring surprise: the C at the beginning of the solo manual is an octave lower than B (on the accompaniment manual) preceding it! A few nasty shocks like that and the organist will be 'conditioned' to avoid such mistakes.

The tone signal's asymmetrical square wave form, which is full of harmonics, provides a sufficiently resonant sound. In addition, the lower manual controls a separate bass output. Since this is monophonic, only the lowest note in each chord that is played will reach the output. The IC's circuitry can be changed to allow the highest note of a chord to be heard at the bass output instead (this requires a logic 1 level at pin 11). The Elektor printed circuit board is however designed to cater for the first version, as this is the one most frequently used.

The bass note, which is derived directly from the IC's output is full of harmonics and, with the aid of a low-pass filter consisting of a resistor and a capacitor (R26/C13) connected in front of a summing amplifier (figure 2), its sound is enhanced with the rich resonance that is characteristic of an organ.

The upper manual has two voices. The sound produced by this keyboard is made up of two square wave signals which each have a separate volume control and differ by one octave in frequency. It is a pity ITT did not add a third or even a fourth square wave signal at one octave higher, as this would have given the IC a really professional touch. Actually, it does not really matter, for when the two square wave outputs are mixed, the solo manual produces a very satisfactory sound. Sub-octaves can be produced by divide-by-two's, provided only one key is struck at a time. If several keys are depressed simultaneously, the corresponding signals will be mixed inside the ICs and will appear in a mixed form at pins 21 and 22.

The circuit diagram

Using the external components shown in figure 2, the Organ IC can be mounted on a very compact printed circuit board.

3

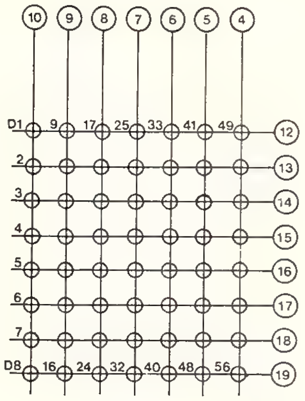


Figure 3. The structure of the keyboard matrix. Only 15 wire connections (to the corresponding 56 pins on the IC) are required for 56 keys to be scanned.

4

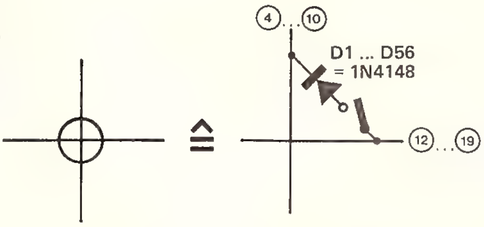


Figure 4. Every junction in the matrix shown in figure 3 consists of a diode and a key

The IC does not include a clock os
lator so that this will have to be add
The economical 74123 TTL IC ser
the purpose admirably.
The two transistors T1 and T2 co
stitute a phase-shift generator. This p
duces a low-frequency sine wave sign
in order to frequency-modulate t
oscillator. The result is a slight vibra
which is exactly what an organ shou
have.
P6 and P7 adjust the vibrato's amplitu
and frequency, respectively. Provid
the two potentiometers are both tri
mers (as indicated on the board), t
vibrato effect can be switched on a
off by means of S1. By mounting
and P7 on the front panel, the frequen
and the amplitude can be regulat
continuously. In fact, the amplitu
can be turned down to zero, so that
may even be omitted here.
P5 serves to alter the entire voice ran
When the wiper of P5 is set in the m
position, the oscillator frequency shou
be 500 kHz. This value must be mai
tained, as the scanner matrix tends
act rather 'strangely' at higher fr
quencies.
If any component tolerances shou
prevent P5 from adjusting the frequen
into the desired range, the easiest wa
to alter the frequency is to select tw
equal capacitor values for C1 and C
The clock frequency's precision can be
be checked with the aid of either a
oscilloscope or a frequency counter.
In order to set the organ's range to th
of other instruments, P5 may be r

5

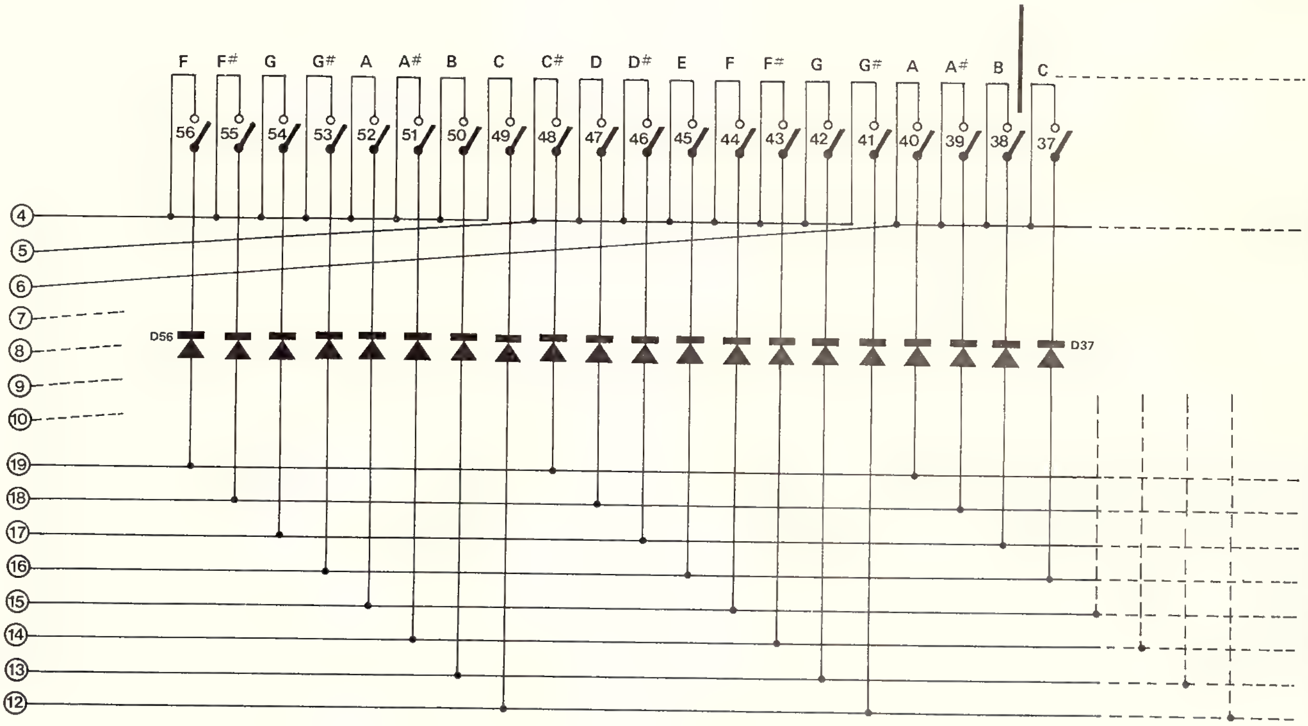
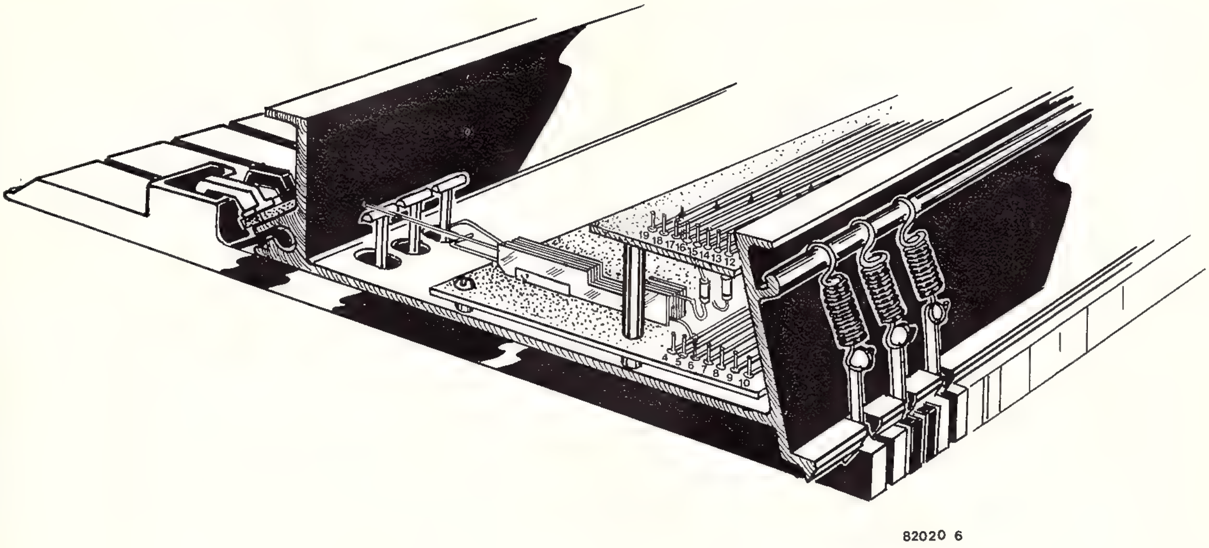


Figure 5. The wire connections for the keyboard: every matrix row contains 8 key contacts, which together lead to connections 4 . . . 10 on the printed circuit board. Each contact and a second link with a diode on the corresponding matrix column track. The links are connected to points 12 . . . 19.



igure 6. The keyboard's mechanical structure. Pieces of Veroboard are ideal for wiring the keyboard. Together with a plastic cover and the ontact blocks, the Veroboard pieces are glued to the keyboard frame.

laced by a potentiometer on the front anel. Pins 2, 21 . . . 23 of the SAA 1900 epresent the signal outputs which are onnected to the output (link F) by vay of a mixing stage (P1 . . . P4 and C3). The latter consists of an inverting pamp in a well-known adder circuit. he bass signal (pin 2) is then sent hrough a low-pass filter before reaching he input of IC3. Outputs A . . . E enable he organ to be extended, if necessary, t a later date and are therefore not con- ected.

he keyboard matrix

he scanner matrix shown in figure 3 is onnected to pins 4 . . . 10 and 12 . . . 19, as indicated in the IC's pin assign- nent. Each one of the 56 junctions in he matrix is made up with a keyboard ontact and a diode (see figure 4). A pecial control circuit inside IC1 scans very junction 'row by row', one after he other, until the key that was de- ressed is detected. In other words, nstead of 7 x 8, only 7 + 8 contacts are equired.

Note: In the matrix shown in figure 3, he lowest note (the first key at the far eft of the keyboard) corresponds to contact number 56. This is situated in he lower right-hand corner, not in the pper left-hand corner, of the figure. To make things clearer: contact num- ers 56 and 1 are assigned to the lowest and the highest notes, respectively. As ong as the contacts are wired in the nanner shown in figure 3 and every natrix point is linked in the manner ndicated in figure 4, nothing can go wrong.

t is not advisable to construct a matrix on the basis of wire and copper track junctions and then connect each one to a key. In practice, the simplest way to construct a matrix is shown in figure 5. This enables the 56 diodes to be incorporated on the keyboard as well. The contacts may not be interconnected. It is best to glue each contact block onto a perspex, plastic or pertinax surface. As far as mounting the diodes is concerned, several pieces of Veroboard should be cut into strips and glued behind the contact blocks, with the copper tracking pattern side facing upwards. The 15-wire connection between the keyboard and the printed circuit board is made by using two (7 + 8) pieces of flat cable (see figure 6).

The power supply and the amplifier

The organ circuit requires a total of five different supply voltages: +15 V, −5 V, −15 V, −18 V and finally a non-stabilised voltage of about −23.5 V. Two integrated voltage controllers (IC4 and IC5) are already included on the organ printed circuit board. These produce −15 V and −5 V respectively. The remaining voltages (−23.5 V, −18 V and +15 V) have to be connected to the organ board. The need for a suitable power supply is met by the circuit in figure 7. This is in fact a dual power supply and produces +15 V and −18 V

7

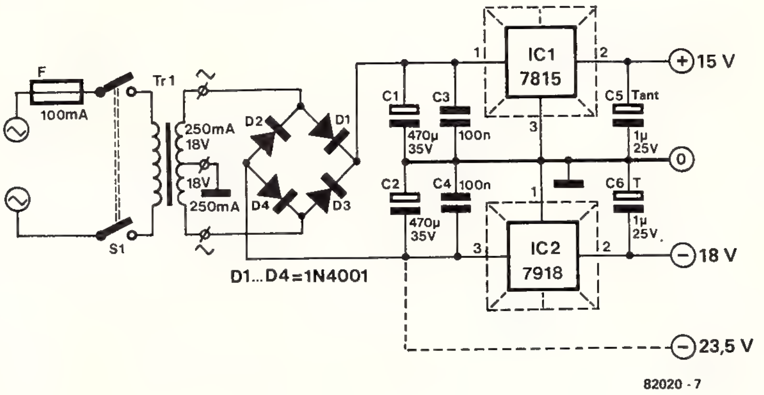


Figure 7. The power supply circuit. The use of a 250 mA transformer enables additional circuits to be powered with up to 150 mA of current as well as the organ board itself. The actual 'organ board' contains the circuit shown in figure 2.

Parts list for the board in figure 8

Resistors:
R1,R2 = 2k2
R3,R5,R14 = 1 k
R4,R12 = 4k7
R6,R10 = 470 Ω
R7 = 33 k
R8,R9,R13,R31 = 10 k
R11 = 15 k
R15 . . . R20 = 47 k
R21 . . . R27 = 22 k
R28 = 680 k
R29 = 330 k
R30 = 18 k
P1 . . . P4 = 100 k log.
P5 = 1 k trimmer
P6 = 2k2 trimmer
P7 = 4k7 trimmer
P8 = 25 k trimmer
P9,P10 = 5 k trimmer

Capacitors:
C1,C2 = 330 p
C3,C15 = 100 n
C4,C5,C6 = 10 µ/16 V
C7,C8,C9 = 4µ7/16 V
C10 = 470 µ/6.3 V
C11 . . . C14,C16 = 330 n
C17 = 1 µ/25 V tantalum

Semiconductors:
T1,T2 = BC 547B
IC1 = SAA 1900
IC2 = 74123
IC3 = 741
IC4 = 79L05
IC5 = 7915

Miscellaneous:
S1 = sp switch
S2 = sp toggle switch

Keyboard:
1 contact per key, totals 56 keys
and 56 1N4148 diodes

8

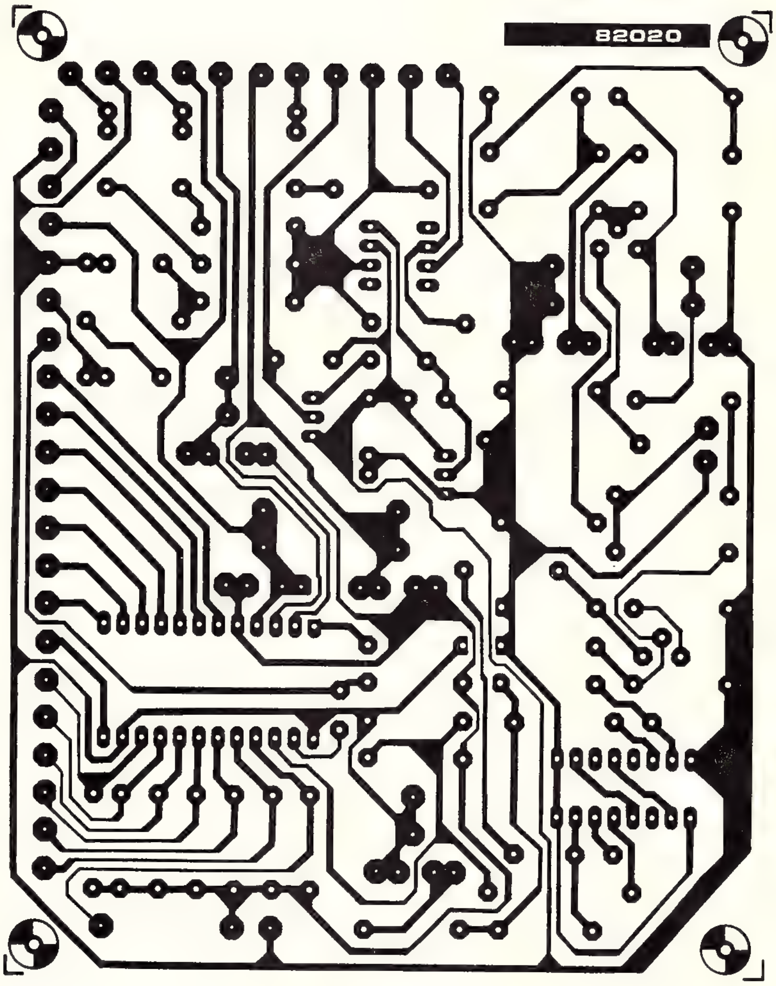


Figure 8. Since all the essential organ functions are already integrated inside the SAA 1900 IC, the printed circuit board is remarkably compact. Outputs A . . . E can be used for further extension purposes later on.

Parts list for the power supply in figure 9

Capacitors:
C1,C2 = 470 µ/35 V
C3,C4 = 100 n
C5,C6 = 1 µ/25 V tantalum

Semiconductors:
D1 . . . D4 = 1N4001
IC1 = 7815
IC2 = 7918

Miscellaneous:
Tr1 = 2 x 18 V/250 mA mains transformer
S1 = dp mains switch
F1 = 100 mA slow fuse

9

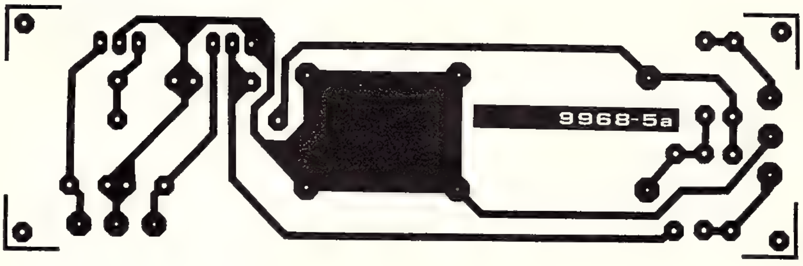
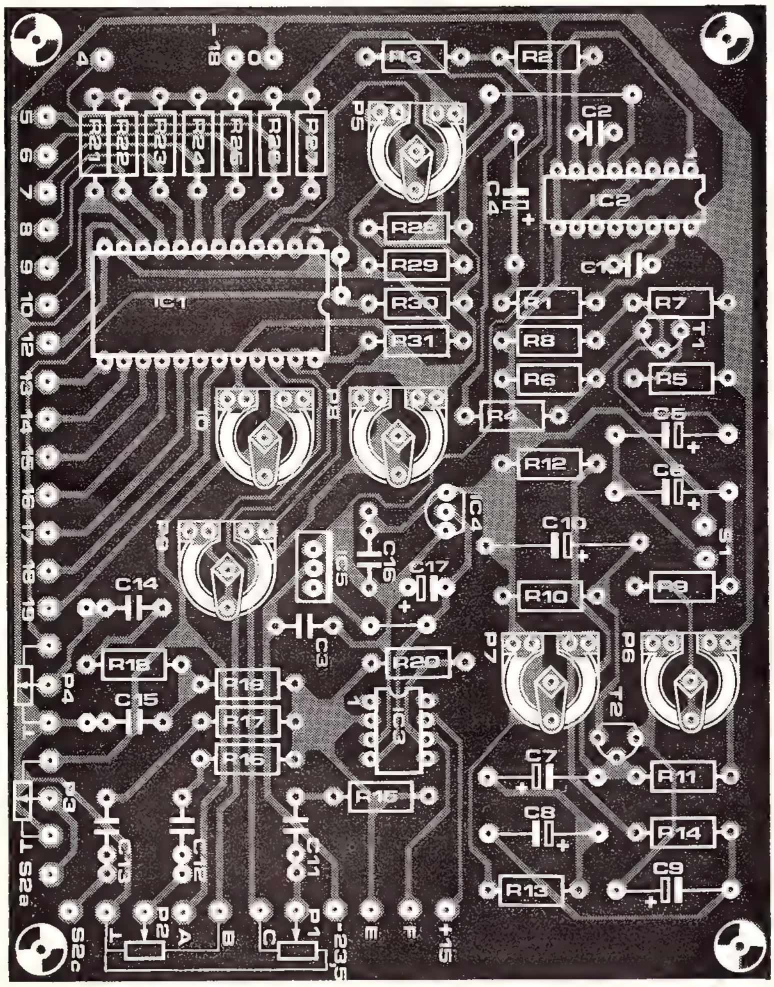
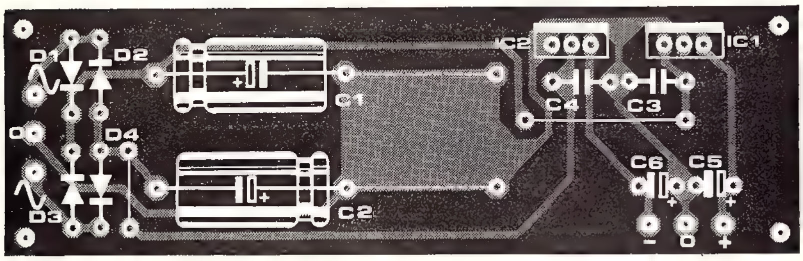


Figure 9. The power supply board for the circuit in figure 7. The wire link situated next to D4 provides the connection for the unstabilised −23.5 V voltage.





with the aid of two voltage regulators. In addition, the required non-stabilised 23.5 V voltage can be derived at the negative pole of the electrolytic capacitor C2. This is done quite easily, since the wire bridge to the right of D4 on the board in figure 9 provides a suitable connection point.

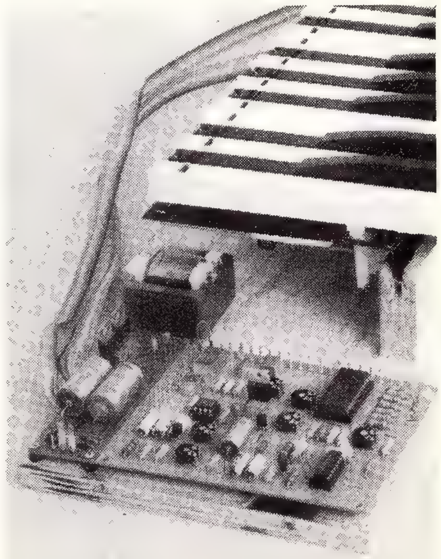
Obviously, the organ's tones, however resonant, will be inaudible without the addition of a miniature amplifier and a loudspeaker. The LF output of the organ (point F) can be connected to any HiFi or PA amplifier. With the aid of P8 . . . P10 the volume at all the IC's outputs (except for the bass signal) can be readjusted once the board is constructed. Furthermore, the opamp's feedback resistor (R20) can be altered in value to match the signal level to the amplifier. (A higher value will cause the volume to be turned up, whereas a lower one will turn it down.)

The keyboard

A great many keyboards are available at an even greater variety of prices. Since an easy-to-play keyboard involves a considerable amount of precision, both with respect to the keys and to the contact blocks, it is bound to be one of the most expensive items in the instrument. How much it costs to build the organ will therefore depend on the price of the keyboard.

The sound

The prototype produced a remarkably convincing sound, which did away completely with our initial scepticism (evoked by the IC's size!). After hearing the first few notes, it was quite obvious that the organ isn't just another toy, but an 'adult' instrument. When it is combined with a monophonic synthesiser, the accompaniment can be played on the organ with the left hand while the right hand plays the melody on the synthesiser keyboard.



telephone amplifier

makes distant callers loud and clear

'Keeping in touch' is easier said than done, despite the modern telephone networks that stretch to the four corners of the globe. For one thing, a pound for a minute seems a lot of money to hear Granny's faint voice ten thousand miles away and then not understand a word she's saying. Elektor has come up with a solution in the form of an amplifier which, when connected to the telephone, enables the whole family to listen in to the conversation.

Some callers, of course, don't nee
amplifying, as anyone blessed with
old aunt who bellows hearty greetin
down one's ear at eight o'clock on
Sunday morning will agree. Here
attenuator would be more appropriat
But then that is an exception. Dista
and sometimes even local lines can
very poor indeed, so that an amplifier
really practical. For instance, whe
relatives ring up from South Africa, sa
or Australia, it would be much mo
economical if the whole family cou
listen instead of having to 'queue u
to say a few costly words. What's mor
the amplifier drowns any interferen
caused by crossed lines and thousan
of 'clicking' relays, so that the on
distant voice sounds as loud and cle
as if the person were sitting in the sam
room.

Now that we know what the amplifier
for, we can study the circuit diagram
figure 1. Looking at the drawing fro
left to right, the circuit starts with
pick-up coil, the centre contains an an
plifier and at the other end there is th
loudspeaker. The pick-up coil operate
according to magnetic principles: an
alteration in the magnetic field that
radiated by wires in the telephone set
in the receiver will be fed to the an
plifier. This slightly roundabout syste
is necessary, since a direct electric
connection to the interior of a tel
phone is forbidden.

The rest of the circuit diagram in figu
1 comprises very few components. L
represents the telephone pick-up co

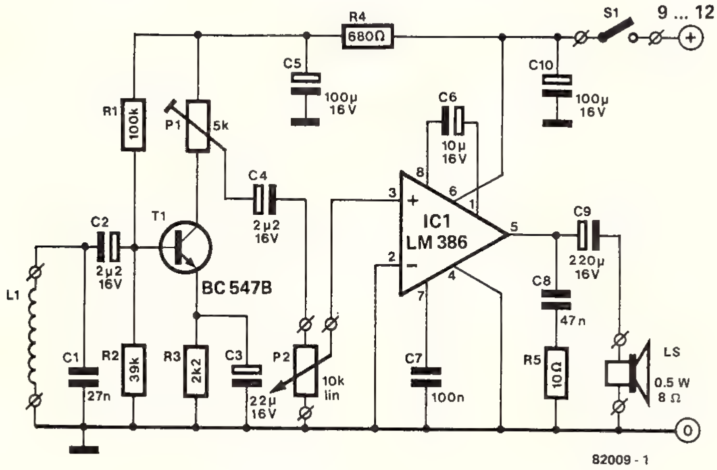
which is specifically designed for this type of application. A very low AC voltage is induced across the coil and this is amplified by transistor T1 and the amplifier IC1 and then fed to the loudspeaker.

There are two ways in which the volume can be adjusted: either by using P1 to set the threshold value or by means of the volume control P2.

A printed circuit board has been designed for the telephone amplifier, the details of which are shown in figure 2. Using a miniature Japanese loudspeaker and a 9 V PP11 battery, the whole circuit will easily fit into a plastic case of roughly 120 x 65 x 40 mm. A mains power supply may also be used, provided the supply voltage is very well stabilised, as otherwise there could be some mains hum.

The construction is very straightforward indeed and so we can proceed with the setting-up, which primarily involves L1 and P1. First of all, the best position for the pick-up coil has to be found. Ideally speaking, this is underneath the telephone, but this would mean having to raise the 'phone a little, since the coil is about 3 centimetres high. Another solution is to fit L1 onto the side of the telephone so that it is close to the amplifier. Readers should decide for themselves what the best practical solution is.

Now for the preset P1. This adjusts the maximum volume. Above a certain level, the sound reaching the amplifier input will be so loud that acoustic feedback ('howl round') will occur. This is a kind of echo that has got out of hand and produces a high-pitched tone. After setting P2 to maximum, P1 is adjusted so that this just does not occur. It would of course be feasible to omit all the components to the right of P2 and use HiFi equipment to reproduce the caller's voice, but then, that is up to the reader.



gure 1. The circuit diagram of the telephone amplifier.

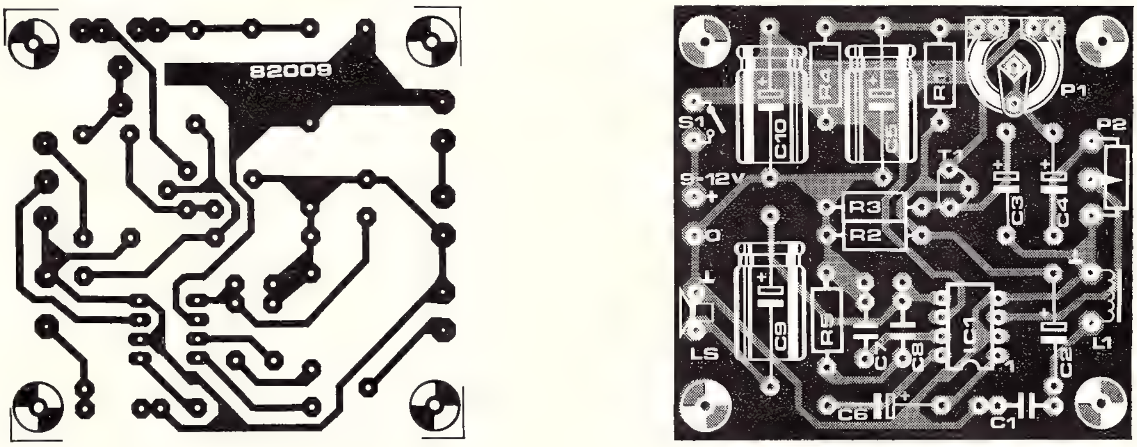
rts list

esistors:
1 = 100 k
2 = 39 k
3 = 2k2
4 = 680 Ω
5 = 10 Ω
= 4k7 (5 k) preset
2 = 10 k linear

apacitors:
1 = 27 n
2,C4 = 2µ2/16 V
3 = 22 µ/16 V
C5,C10 = 100 µ/16 V
C6 = 10 µ/16 V
C7 = 100 n
C8 = 47 n
C9 = 220 µ/16 V

Semiconductors:
T1 = BC 547B
IC1 = LM 386

Miscellaneous:
L1 = telephone pick-up coil
LS = 8 Ω/½ W miniature loudspeaker
S1 = on/off switch



igure 2. The printed circuit board track pattern and component layout for the telephone amplifier.

sine-wave oscillator

very low distortion . . . .

L. Boullart

Nowadays, an entire function generator can be constructed from a few simple ICs. When measuring low-frequency equipment, such as audio amplifiers, it is highly desirable to use a low distortion, reliable sinewave generator.
This particular design is not at all complicated as far as construction is concerned and yet it boasts a distortion level of only 0,01%! Its frequency range extends from 10 Hz up to an inaudible 100 kHz and is very simple to operate.

Where modern HiFi equipment — especially the home-constructed kind — is concerned, accurate measurements are almost impossible to carry out. Although frequency characteristics and squarewave signals can be checked, there is little that can be done towards measuring the actual distortion level, that is, assuming the unit is properly built and the amplifier is working correctly. Fortunately, most up-to-date designs are so good, that the distortion level will be negligible. In any case, it is hardly worth buying an expensive oscillator with an extremely low distortion factor and a first-class distortion meter to carry out one or two measurements.
An oscillator can be built in a number of different ways, each particular design having certain advantages and disadvantages. For low-frequency measurements, where the frequency needs to be varied, it is best to use a 'Wien bridge oscillator'. This type of circuit provides low distortion and allows the frequency to be changed fairly easily with the aid of a stereo potentiometer or a dual-ganged capacitor. The design described here is quite compact and straightforward, but nevertheless it is eminently suitable for measuring frequency characteristics and distortion levels. In addition, a Schmitt-trigger has been included in the circuit to provide squarewave output signals.

The oscillator circuit

Although most readers will probably know how an oscillator containing a Wien network works and have reference books in which they can look it up, it might not be a bad idea to go into the matter here.
Figure 1a shows a network of two resistors and two capacitors. This constitutes the frequency-determining section of the Wien oscillator. If the transfer function is calculated as U_1/U_0, the result will show that there is only one frequency with no phase shift between U_1 and U_0. This will be at the frequency: $F = 1/(2.\pi.R.C.)$. At this frequency the ratio of U_1 to U_0 will be exactly 1:3. If the U_1 voltage is amplified by a factor of three and then fed back to U_0, as drawn in figure 1b, a perfect oscillator is obtained (since the U_1 and U_0 signals are in phase at that particular frequency). Unfortunately, however, there aren't any opamps available with a manufactured gain of three. As figure 1c shows, this does not matter, as the solution is to connect the RC network between the non-inverting input and the output of an ordinary opamp. A voltage divider (R1, R2) is

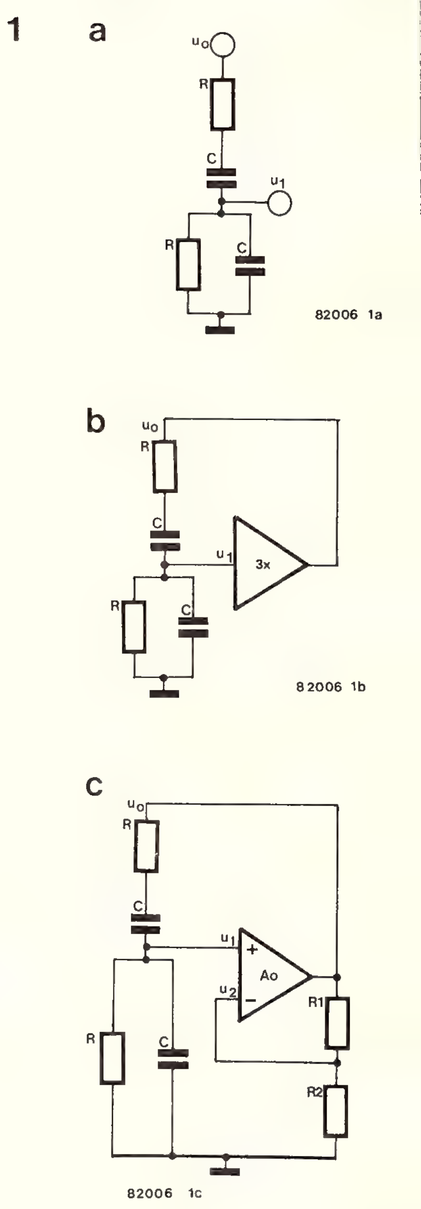


Figure 1. This drawing shows how a Wien bridge can be used to create an oscillator. The voltages U_1 and U_0 will only be in phase for one particular frequency, where U_1 is but 1/3 of U_0. By amplifying the voltage U_1 by a factor of three and feeding it back to U_0, an oscillator can be obtained.

nnected to the inverting input of the amp. The R1/R2 ratio is calculated ice, so that the amplification factor ll be:

$$A_u = \frac{R1 + R2}{R2} = \frac{2.R2 + R2}{R2} = 3.$$

ere will now be a sinewave signal at e output of the opamp with a fre- uency based on the formula provided ove. In practice, the amplification ctor of three is rather critical, since it very difficult to maintain both at the amp side and at the RC network side. the amplification slightly exceeds a ctor of three, the amplifier's output ll produce an everincreasing output gnal until this is limited by the supply ltage. The opamp will then produce a uarewave. If, on the other hand, the nplification factor drops slightly the cillator will either stop operating simply not start in the first place. en no output signal will be produced all. Obviously, some sort of control stem is needed to adapt the gain so at the circuit oscillates, without fecting the supply voltage. Only then ll the output be able to produce a mmetrical sinewave signal.

sually, such a control system can be t up by choosing a temperature-pendent resistor for either R1 or R2. hen the output voltage increases, the current passing through the temperature-dependent resistor will also rise, causing its resistance to be altered. As a result, the opamp's amplification will be reduced. If, however, the output voltage drops, less current will pass through the feed-back resistors and so the resistance will change causing the gain to be increased. This method leads to an equilibrium, where the output voltage is constant.

The circuit diagram

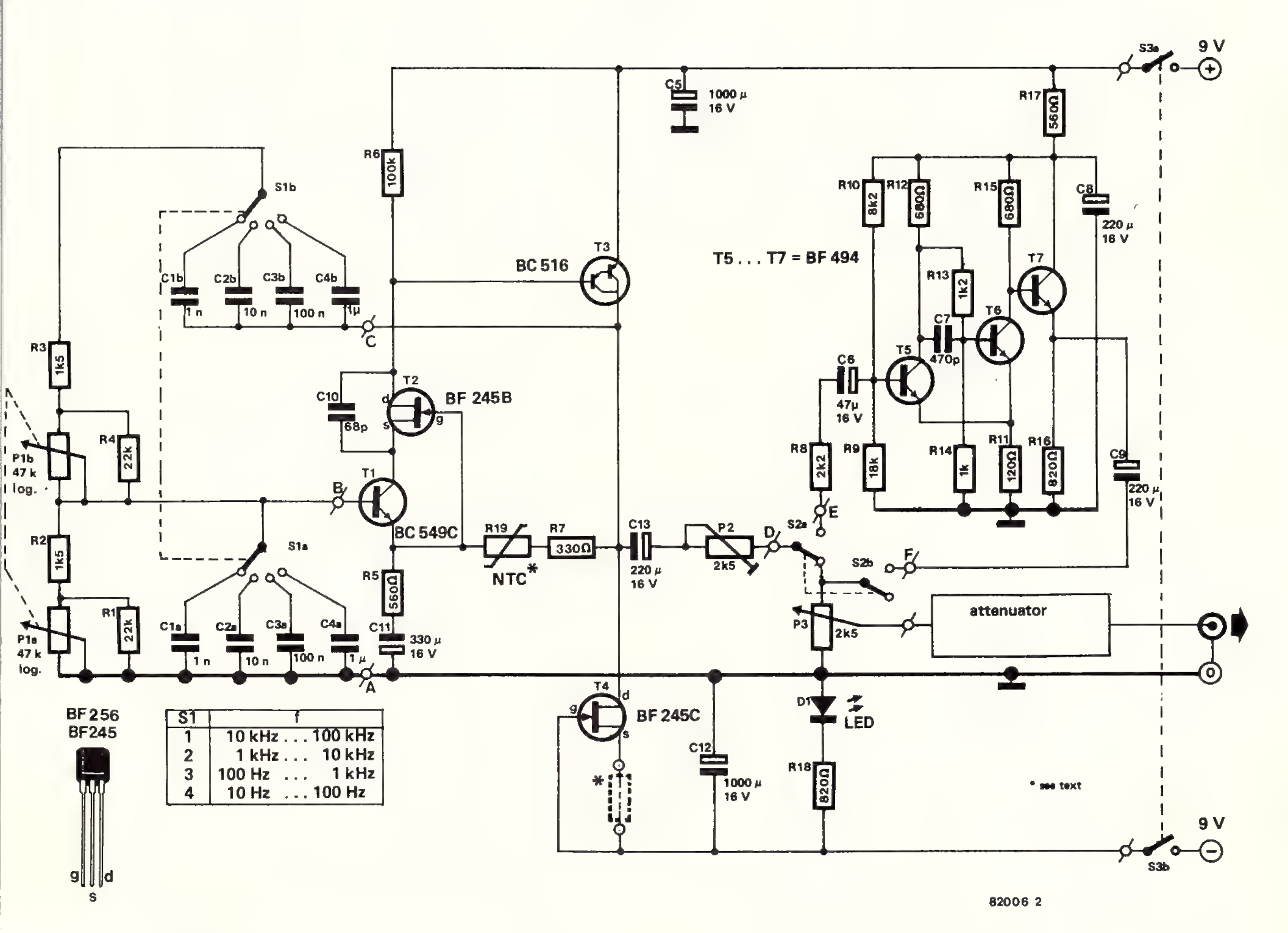
Figure 2 shows the circuit diagram for the sinewave oscillator. It looks quite different from the block diagram in figure 1. The opamp here is discrete in structure and consists of transistors T1 . . . T4. The input stage is formed by a cascode circuit containing a bipolar transistor (T1) and a FET (T2). In order to obtain a considerable open loop gain, a Darlington transistor was chosen for T3. By means of the current source formed by T4, the collector is linked to the negative supply voltage.

The bridge section comprising the resistors and capacitors is connected between the collector of T3 and the base of T1. Use has been made of a stereo potentiometer with a logarithmic characteristic to regulate the frequency continuously. Switch S1 acts as a range switch and provides other capacitor values. The four positions provide an overall frequency range of 10 Hz . . . 100 kHz, which amply serves most audio purposes.

The amplitude is stabilised with the NTC resistor R19. The type chosen has a resistance of 1k5 at 25°C. This produces an output amplitude of about 1.5 V_{RMS}. It is very important to use the right type of NTC here, for if the wrong one is used the distortion level will rise alarmingly. The one used here is housed in a glass package with a maximum power dissipation of 20 mW. The latter is vital, as current passing through the NTC has to heat it.

The output signal is fed to P3 by way of C13 and preset P2 (which presets the maximum output voltage). This output level control is followed by an attenuator which has been drawn separately.

Switching S2 connects a Schmitt-trigger in series with the output lead, so that squarewave signals are also available. The Schmitt-trigger consists of transistors T5 . . . T7 and the associated components. As readers can see, the circuit has a standard structure and could have been copied straigth out of a text book. However, the square wave signals it produces are of a high enough quality



S1	f
1	10 kHz . . . 100 kHz
2	1 kHz . . . 10 kHz
3	100 Hz . . . 1 kHz
4	10 Hz . . . 100 Hz

igure 2. The circuit diagram of the sine-wave oscillator. On the right-hand side a Schmitt-trigger is shown which generates square wave signals. he attenuator is shown in figure 3.

3

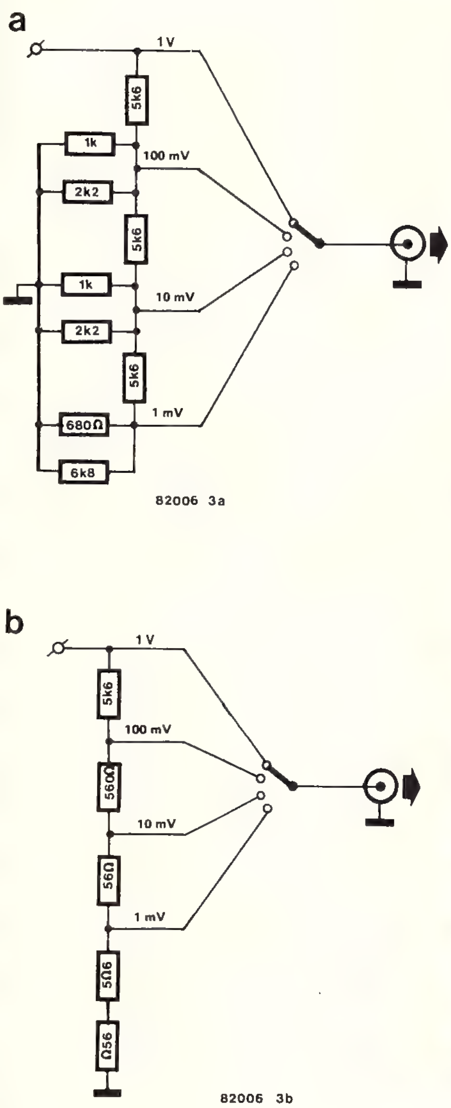


Figure 3. Two different ways in which to build an attenuator. The first version has a constant output impedance of 565 Ω (except when it is set at 1 V), whereas the second has a variable output impedance. The latter version is much more straightforward.

4

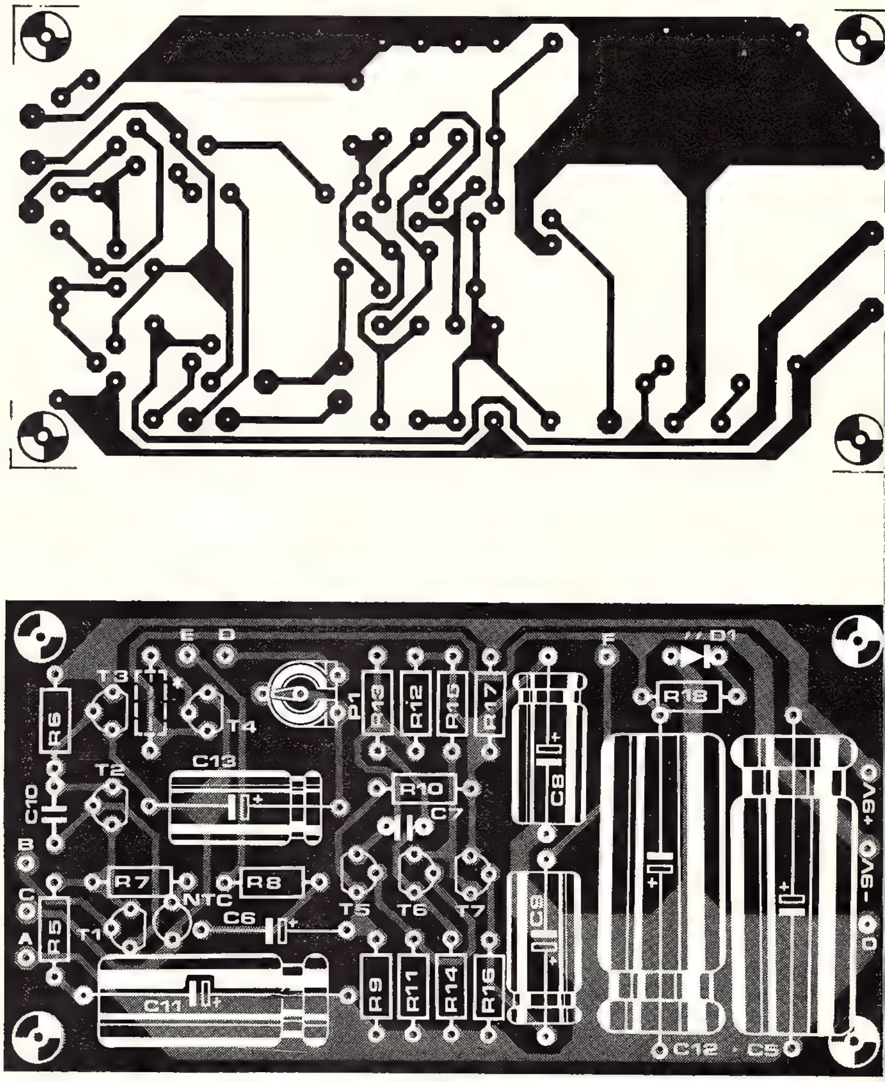


Figure 4. The printed circuit board and the component overlay for the sine wave oscillator circuit. Some of the resistors and capacitors shown in figure 2 are soldered directly to the various potentiometers and switches.

for audio purposes. The only disadvantage involved in the circuit, is that the mark/space ratio is somewhat dependent on supply voltage, although this is really of minor importance in this particular application.

Figure 3 shows two attenuator circuits. Usually signal generators feature an output impedance of 600 Ω. The same can be done here by using the attenuator in figure 3a. In order to obtain an output impedance of exactly 600 Ω for every stage, the resistors will have to have rather "odd" values. If, on the other hand, a slightly irregular output impedance is acceptable, the standard values indicated in the circuit diagram will do. The output impedance will be around 565 Ω. It is only at the highest output level that the impedance will be altered between 0 . . . 5 k (depending on the position of P2 and P3). Provided readers do not require on a standardised output impedance, they can use the attenuator in figure 3b. The output impedance will then of course no longer be constant, but in most cases this does not really matter.

Finally, we still have to mention the LED D1 with its series resistor. This indicates when the oscillator is activated. At the same time, the LED ensures that the circuit's current consumption is equal for both the positive and the negative supply if it is battery-powered. (The current consumption of the LED has been chosen to be the same as that of the Schmitt-trigger circuit.)

Construction and calibration

The easy way out is, of course, to buy the board and the parts from your loca retailer, solder the lot together an Bob's your oscillator. The device wil indeed oscillate, but don't be surprise if it turns out to have a considerabl distortion factor. Obviously, a littl bit more is required. To start with R5 . . . R7 should be metal foil type having a 1% tolerance. The stere potentiometer P1 needs to be a goo tracking type. Capacitors C1 . . . C should also be 1% types, if available This is not absolutely essential, but i does lead to an accurate scale divisio for every range. T1 must be a low-nois transistor. Nowadays, various Japanes transistors have an ever lower nois factor than the types mentioned i the parts list. A good example is th 2SC2546, but unfortunately this type i not yet readily available. In addition

ts list

sistors:
,R4 = 22 k
,R3 = 1k5
= 560 Ω
= 100 k
= 330 Ω
= 2k2
= 18 k
0 = 8k2
1 = 120 Ω
2,R15 = 680 Ω
3 = 1k2
4 = 1 k
6,R18 = 820 Ω
7 = 560 Ω
9 = NTC 1k5 at 25°C Philips
/pe 2322 31152
= 47 k log stereo
= 2k5 preset
= 2k5 potentiometer

pacitors:
a,C1b = 1 n
a,C2b = 10 n
a,C3b = 100 n
a,C4b = 1 µ (not an electrolytic type)
,C12 = 1000 µ/16 V
= 47 µ/16 V
= 470 p
,C9,C13 = 220 µ/16 V
0 = 68 p
1 = 330 µ/16 V

miconductors:
= LED
= BC 549C, BC 550C
= BF 245B, BF 256B
= BC 516
= BF 245C
,T6,T7 = BF 494

iscellaneous:
= double pole, 4 position wafer switch
= double pole toggle switch
= double pole switch

ie voltage at T2 will have to be easured once the circuit has been conructed. This transistor should be a pe that has a drain current of 12 µA a gate-source voltage of −3 V (we will me back to this later). For this reason, might be a good idea to place a transtor socket in this position on the ard first.

get back to building the circuit, part it is not mounted on the board. This cludes the frequency-determining netork at the circuit input (everything quired for connections A . . . C) and e switch S2 together with potentioeter P3 and the attenuator.

the input circuit the capacitors are ldered directly to switch S1 and ewise the resistors R1 . . . R4 to the ereo potentiometer. This section is en connected to the board by means of three wires, after the rest of the components have been mounted. Points D . . . F are then linked to switch S2 and potentiometer P3 is wired. Finally, the resistors belonging to the attenuator are mounted straight onto the switch. Then the supply voltage has to be connected up by way of switch S3.

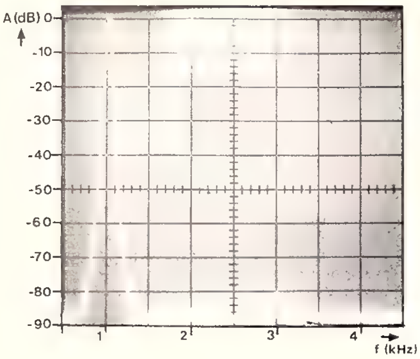


Photo 1. Shown on a spectrum analyser are the oscillator's distortion residues at a frequency of 1 kHz. The first large peak represents the 1 kHz signal. The first even harmonics are at a level of −85 dB with respect to the 1 kHz signal, or rather at 0.006%. The first odd harmonics contribute 0.01% (−80 dB).

The power supply may be a straightforward mains type, consisting of a small transformer, a bridge rectifier, one or two electrolytic capacitors and two voltage regulators similar to those published previously in Elektor. Current consumption will be about 23 mA.

Seeing as the current consumption is so low, the circuit may also be battery-powered. Using four 'flat' 4.5 V batteries, the lifespan during intermittent use will be a reliable 100 . . . 200 hours.

Figure 4 shows the printed circuit board for the sinewave oscillator. A resistor is indicated by way of a dotted line next to transistor T3 . Once the entire circuit has been built, in the manner described above, a multimeter is connected between the two connections of the dotted resistor and the meter is switched to current measurement (DC!). After the supply voltage has been switched on, the current measured should be about 15 mA. If it is any higher than this, a resistor should be connected in series with the meter and have a value that makes the meter indicate 15 mA. Depending on the result, the resistor or, if not required, a wire link, is soldered onto the board.

The voltage is then measured at T2. Initially this is measured between the source and the gate and then the meter is switched to current measurement and connected to the drain. Several transistors of either the BF 245B or BF 256B type should be experimented with and the one that comes closest to meeting the $V_{GS} = -3$ V and Id = 12 µA requirement is soldered onto the board.

After this the output voltage can be measured. This is usually around 1.5 V_{RMS} (measured at the junction of R7 and C13). If necessary, the output voltage can be altered slightly by choosing another value for R7. Once this has been done, P2 is adjusted so that the output voltage at the wiper of P3 is exactly 1 V_{RMS} when the latter is turned fully clockwise. The attenuator can then be used to select a lower output voltage, 100 mV, 10 mV or 1 mV, which can also be attenuated with the aid of the potentiometer.

If the squarewave signal observed on an oscilloscope screen looks slightly asymmetrical, the solution is to alter the value of R8. Finally a word of advice: the output amplitude can be kept at a constant level by covering the NTC with a layer of insulating material, such as foam rubber.

Easier said than done . . .

This circuit is a perfect example of how an effective device can be built without the need for a lot of ICs or other fancy components. All that the enthusiast has to do is think carefully and decide what the circuit is to achieve and then select the best possible components. The result is a compact design with excellent features. That is exactly how the designer created the prototype which has a distortion level of 0.01% at 1 kHz. The designer even maintains that distortion levels as low as 0.0014% at 1 kHz is possible! The frequency range coveres 10 Hz . . . 100 kHz within 0.15 dB. These are very satisfactory results by any standards. If such a circuit still is not capable of testing a particular audio amplifier, the amplifier must be of such a high quality that there isn't any point in measuring anything anyway! ◼

part two

teletext decoder

. . . that does not require modifications to the TV set

After the detailed introduction to Teletext given last month, this article deals with the practical side of the project. To keep the whole thing within manageable limits, the circuit description will be as brief as possible. This leaves room to pay closer attention to three important aspects: modifying a TV set if the decoder is to be built in; calibration procedures; and, last but not least, the instructions for use.

This article concerns the Teletext d
coder and the circuit-diagram for it
shown in figure 1. This is a repeat
figure 13 in part 1, so many reade
may already be familiar with it. Tl
function of the various LSI chips ha
already been discussed in part on
therefore the operation of this part
circuit should be fairly clear, at least
the main outlines.

The ICs 5 through 9 form the exterr
address counter and page memory (s
SAA5020 of part 1). The remainin
part is the control which is clear
separated from the decoder in tl
circuit-diagram. There are only thr
connections between the decoder ar
the command/control section, since IC
can only be given orders in serial forr
This procedure saves IC pins.

Control (handling)

The layout of the command section
again divided into two parts (see figu
2). In fact, the real control is carried o
by the keyboard with its encoder co
sisting of IC17, IC18 and IC19. The r
maining ICs (IC11 . . . IC16) convert th
parallel information of the keyboar
which is available at points C, D,
F, G and H, into a synchronous seri

2

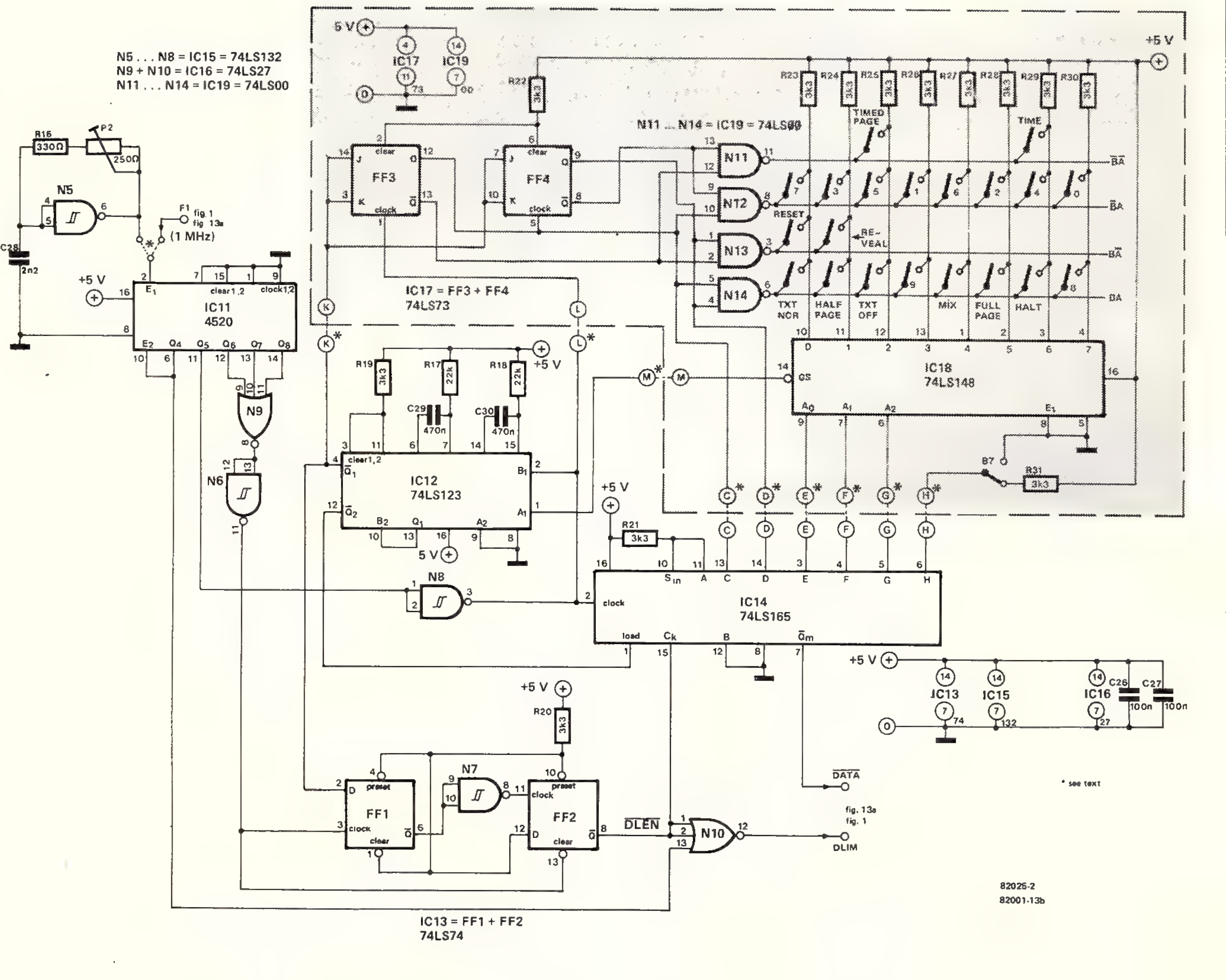
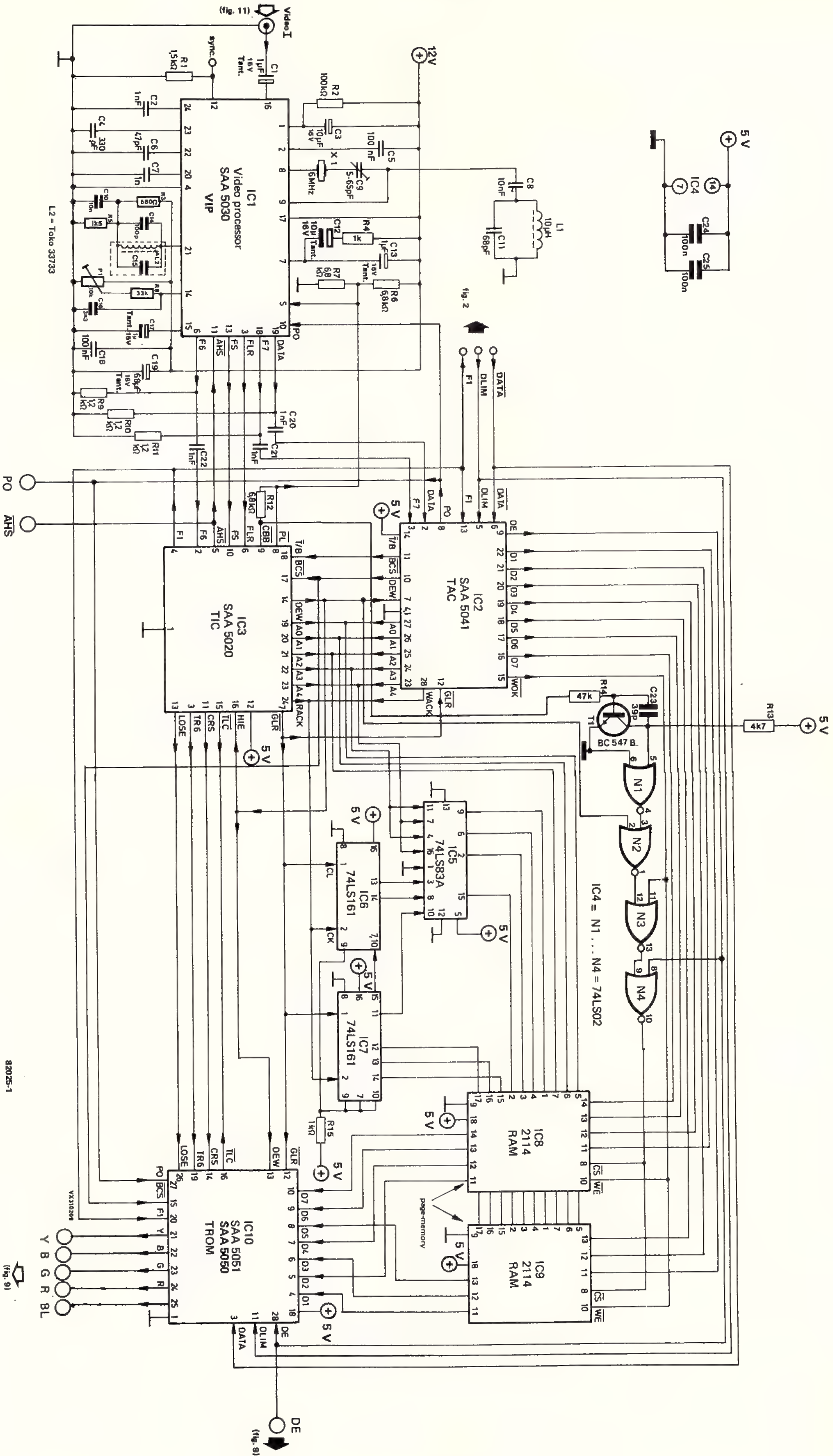


Figure 2. The control section of the decoder. The shaded part of the circuit is placed on a separate printed circuit board.



igure 1. The circuit diagram of the decoder section. Note that this drawing differs slightly from the basic circuit given as figure 13a in part 1.

3

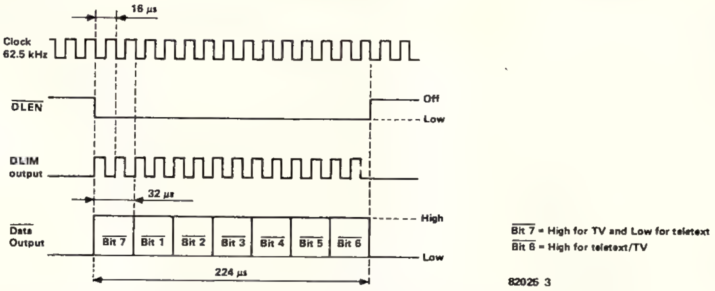

16 µs
Clock
62.5 kHz
$\overline{\text{DLEN}}$
Off
Low
DLIM
output
32 µs
High
$\overline{\text{Data}}$
Output
$\overline{\text{Bit 7}}$
$\overline{\text{Bit 1}}$
$\overline{\text{Bit 2}}$
$\overline{\text{Bit 3}}$
$\overline{\text{Bit 4}}$
$\overline{\text{Bit 5}}$
$\overline{\text{Bit 6}}$
Low
224 µs
$\overline{\text{Bit 7}}$ = High for TV and Low for teletext
$\overline{\text{Bit 6}}$ = High for teletext/TV
82025 3

Figure 3. The parallel code of the keyboard output must be converted to serial information. The pulse diagrams in this figure indicate how this conversion is performed.

output. In this context synchrono
means that the clock-signal necessa
for decoding the serial signal is al
transmitted. Figure 3 shows how tl
keyboard code is supplied serially
IC2 (SAA 5041). The DLIM-signal
derived from a 62.5 kHz clock-signa
which in its turn is produced by dividi
a 1 MHz-signal. This can either be d
rived from the keyboard itself or fro
IC3 (see figure 1). Figure 1 indicat
that the signal from IC3 is derived fro
the 6 MHz oscillator (crystal controlle

Parts list Teletext decoder board

Resistors:
R1,R5 = 1k5
R2 = 100 k
R3 = 680 Ω
R4,R15 = 1 k
R6,R7,R12 = 6k8
R8 = 33 k
R9 . . . R11 = 1k2
R13 = 4k7
R14 = 47 k
R16 = 330 Ω
R17,R18 = 22 k
R19 . . . R21 = 3k3
P1 = 10-k-preset
P2 = 250-Ω-preset

Capacitors:
C1,C13,C17 = 1 µ/16 V Tantalum
C2,C7 = 1 n
C3,C12 = 10 µ/16 V Tantalum
C4 = 330 p
C5,C18,C24 . . . C27 = 100 n
C6 = 47 p
C7,C20 . . . C22 = 1 n
C8,C10 = 10 n
C9 = 5 . . . 65-p-Trimmer
C11 = 68 p
C14 = 100 p
C16 = 3n3
C19 = 68 µ/16 V printed C mounting
C23 = 39 p
C28 = 2n2
C29,C30 = 470 n

Semiconductors:
T1 = BC 547B
IC1 = SAA 5030 VIP
IC2 = SAA 5041 TAC
IC3 = SAA 5020 TIC
IC4 = 74LS02
IC5 = 74LS83A
IC6,IC7 = 74LS161
IC8,IC9 = 2114 RAM
IC10 = SAA 5050 TROM
IC11 = 4520
IC12 = 74LS123
IC13 = 74LS74
IC14 = 74LS165
IC15 = 74LS132
IC16 = 74LS27

Miscellaneous:
L1 = 10 µH
L2 = 33733 (TOKO)

4

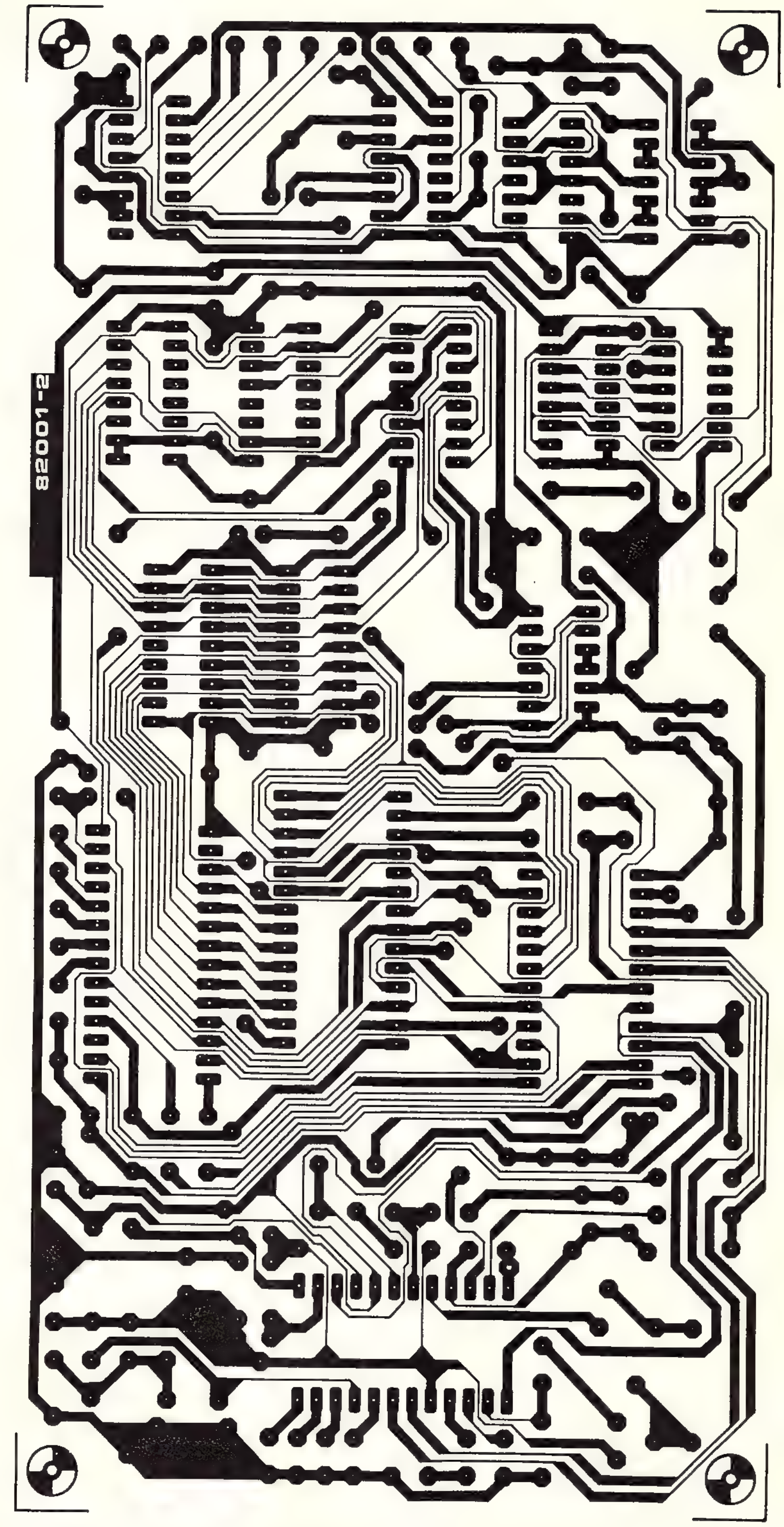
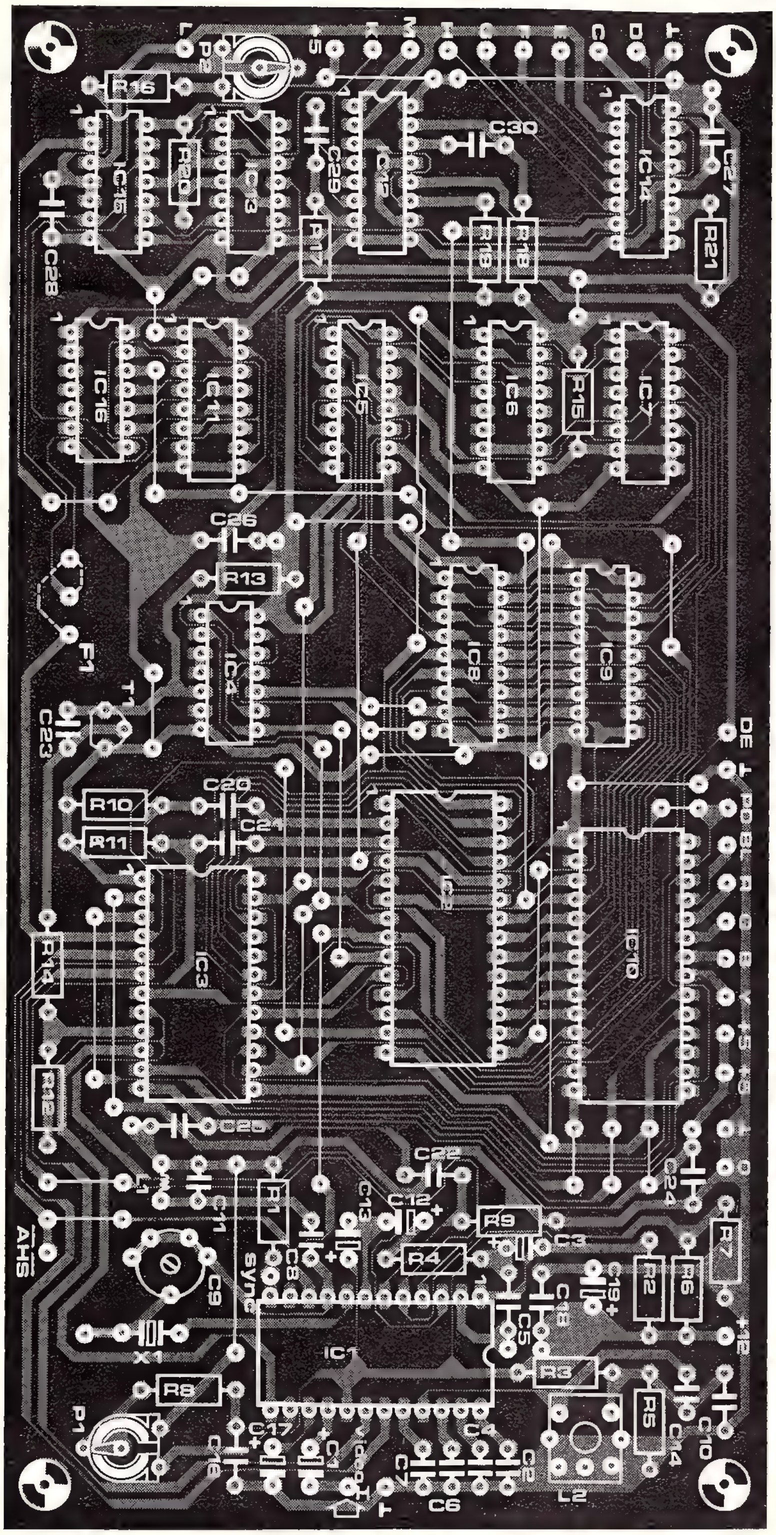


Figure 4. The printed circuit board layout for the *Teletext decoder*. The indicated connection points must be linked to the corresponding points on the other boards.

f IC1. So using F1 has the advantage at the transmission speed of the com-and switch (DATA and DLIM) does ot have to be trimmed. In order to ake testing of the keyboard possible ithout the aid of the Teletext decoder, e oscillator can be built around N5.

he keyboard is only a local control r the Teletext decoder so far. Control ver a greater distance using remote ntrol is possible, but a completed esign is not available yet, although reparations have been made. The separation between the keyboard encoder and the parallel series converter has already been carried out on the printed circuit boards. The keyboard code is fed to the parallel series converter via nine connections. In this way a selecting circuit can be added, which makes it possible to choose between local and remote control.

The converter section is combined with the Teletext decoder in order to make it easier to separate the units, as described above. This means that the keyboard printed circuit board only contains IC17, IC18 and IC19, which will simplify the installation of this board in the front of a case. The keyboard may be used at a distance of up to one metre from the decoder board. To avoid problems with interference inherent with longer distances, buffers must be added (at the transmitting as well as the receiving end).



Boards 1 and 2

Figures 1 and 2 give the complete circuit of a Teletext decoder that is suitable for building into a TV set. Figures 4 and 5 show the corresponding printed circuit boards. Only the shaded part of figure 2 is shown on board 2 (figure 5). All the keyboard connections are brought out together in the form of an 11 way ribbon cable between the keyboard and the decoder. With only a few exceptions, the same is true for the connections to the video circuit board (to be described next month).

All boards are 10 cm in width and the length of the decoder board is 20 cm. This enables the keyboard and video circuit boards to the placed beside each other, near the decoder, allowing the connections between them to be kept short.

Modification of the TV set

Although the decoder was not originally intended to be fitted into the TV set we will pass on a few hints for readers who wish to do so.

Only very rarely can the video signal in a TV set be interrupted. Even sets with a video recorder connection socket aren't satisfactory in this case, since they provide an input *or* output for the video signal but the Teletext decoder needs both possibilities at the same time.

Most TV sets are still produced without a power transformer nowadays, so they may have a live chassis. This problem can be overcome by the use of an isolation transformer (figure 6). It is possible for the transformer to be built into the TV set without too much difficulty but connecting a video input and output is slightly more complicated. It is useless attempting this without a layout diagram of the TV set. Fortunately a diagram is almost always supplied with the set itself, otherwise it may be obtainable from the dealer or a service company.

Figure 7 shows a part of a TV circuit and the modifications necessary for the connection of Teletext or any other video signal. A break must be made between the video demodulator and -amplifier. Considering the modular construction of a TV this spot should not be too hard to find. The signal amplitude should be 2-3 V peak-to-peak. In the circuit diagram of a TV set this is usually indicated, as in figure 7, near a sketch of the waveshape at this point.

5

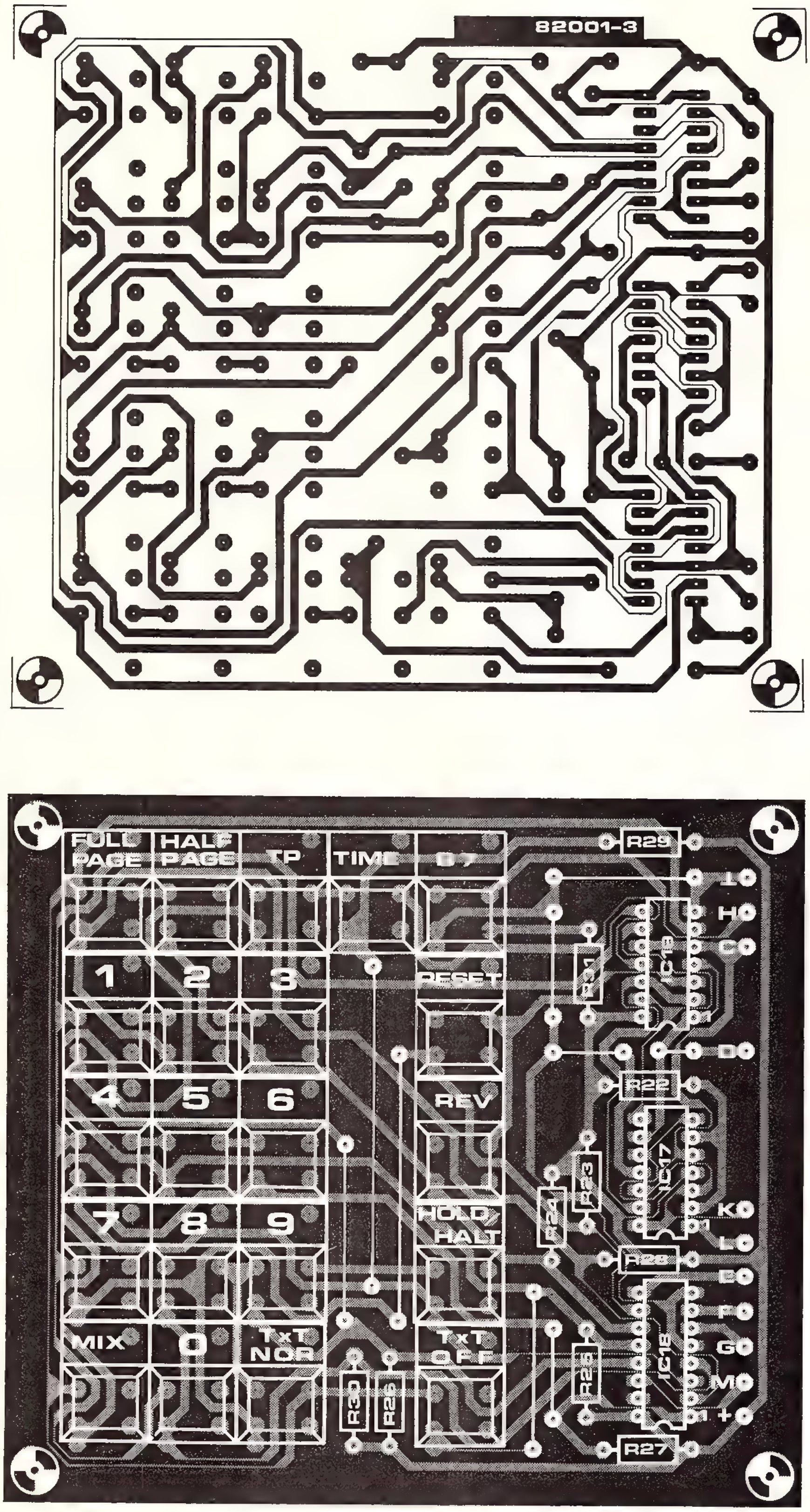


Figure 5. The printed circuit board and component overlay of the *keyboard section*. Since only the shaded part of figure 2 is placed on this board, it contains just three ICs besides the keys.

Parts list

Teletext decoder keyboard

Resistors:
R22 . . . R31 = 3k3

Semiconductors:
IC17 = 74LS73
IC18 = 74LS148
IC19 = 74LS00

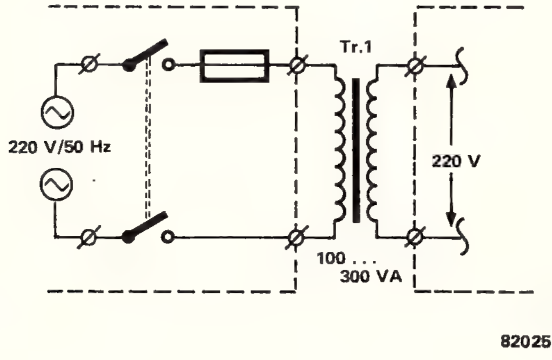
Miscellaneous:
21 x digitast switch
(Digitasts serve as wire links)

The interruption of the video co nection may influence the AGC (Aut matic Gain Control) of the tuners. Th would lead to much poorer receptic quality, or even: no reception at al Whether the AGC is influenced (situ ation B of figure 7) or not (situation A must be checked on the TV circu diagram. In the unhoped-for event tha situation B occurs the AGC must b switched over to a Manual GC (via S_b The Manual GC control must be ac justed separately for each transmitte due to the differences in receptio Fortunately, situation B occurs mainl in relatively old black and white T sets. The video output is easy to co nect once the right spot is found Figure 7 shows how this is done. Th DC voltage level, on which the vide signal is super imposed, is used to bia the emitter follower T1. Via C3 and R5 the signal can be brought out to a coa (BNC) connector on the back of th TV set, or else a connection can b made directly to the decoder. In th event that the amplitude of the vide signal is over 3 V, R4 can be replace by a trimmer to enable adjustment c the output amplitude.

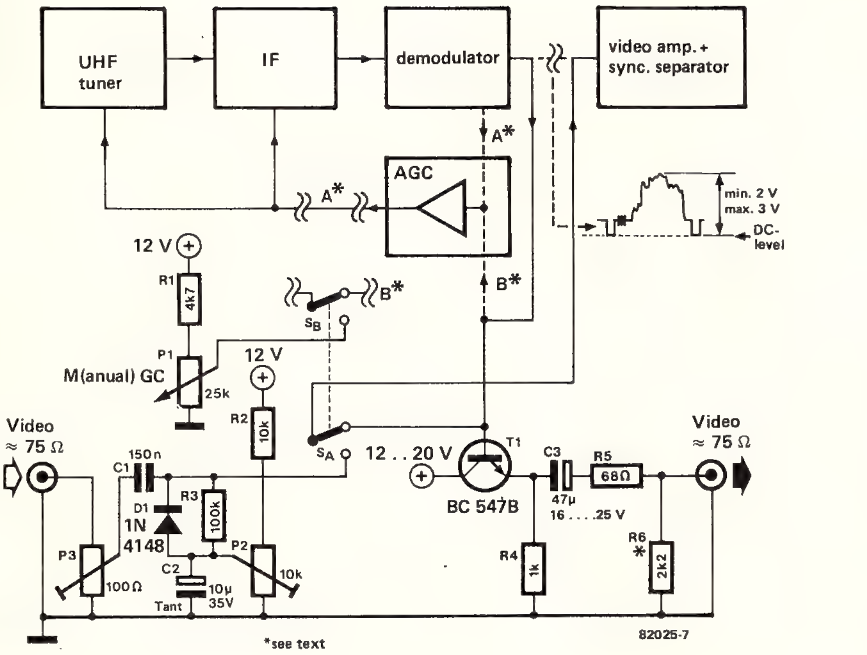
The video signal must never be greate than 6 V. The supply voltage for T must also be derived from somewher in the TV. Most tuners are connected t 12 V, so a supply can probably be foun in that vicinity.

The video input circuit which can b switched by S_a should return the ampl tude of the video signal to the desire value (P3) and super impose the vide signal on the required DC voltag component. Adjustment of P2 dete mines the DC voltage level of the syn pulses via D1 (see figure 7). With th component values given, this level ca be set between 0 V and 6 V. If a highe voltage is required a smaller value ma be chosen for R2.

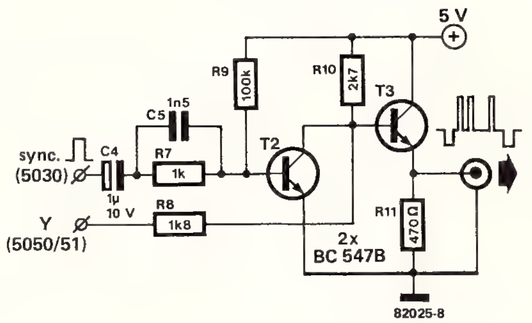
These modifications are not onl suitable for the Teletext decoder. Th design is such that input and outpu impedance are approximately 75 Ω Therefore a TV set with this input stag can also serve perfectly well as a vide



ure 6. The TV set must be isolated from the mains when it is supplied with a video input -output. Generally an isolation transformer can be built in very easily.



ure 7. Most TV sets can be modified to provide a video input and output. The block diagram icates where the video signal must be connected inside the TV. The block diagram of the TV l either look like situation A or B.



ure 8. The signals from the Teletext decoder must be mixed in this little video combiner, ore they can be applied to the video input.

monitor, for example with a video game. In that case a coaxial cable must be used for the signal connection.

Video combiner

Although the TV set is provided with a video input stage, the Teletext decoder signals are not yet fit for this input. The sync signal from SAA 5030 (IC1) and the Y-signal from SAA 5050 must first be combined to achieve this. This is carried out by T2 and T3 (see figure 8). The sync signal at pin 12 of IC1 has a (positive) amplitude of about 0.7 V, so the base of T3 is short-circuited during the sync pulses and the output becomes 0 V.

The Y-signal is supplied by one of the open-drain outputs of IC10. This signal contains the luminance information of the Teletext picture. The proportion of R8 and R10 is chosen in such a way that the combined video signal is modulated up to approximately 60-70% white. Since the complete amplitude is 5 V, P3 (at the video input) will have to reduce the level to 2 to 3 volts.

Switching over from Teletext to normal reception is simple: S_A (+S_b) is the selector switch.

With or without frills?

The quickest (and cheapest!) way to Teletext is to build the simple decoder described so far into a modified TV receiver. However, this does severely limit the flexibility of the system.

In the first place, the Teletext picture will not be reproduced in colour. This is not too serious, perhaps, but there is more: the automatic switching facilities of the Teletext system are also lost. Consequently, some useful features like subtitles for the deaf can not be utilised. Furthermore, no time indication can be superimposed on the normal TV picture and, in general, the Teletext information and normal TV picture cannot be displayed simultaneously. The video control board (to be described next month) does add all these facilities – but it is by no means a simple circuit. The output from this unit can be connected to the video input described above.

An even more interesting alternative will also be described. With a little add-on circuit, it is possible to feed the Teletext signal into the aerial input of the TV set. This has the major advantage that it is no longer necessary to dig into the inside of the TV set, provided a seperate receiver section is also included to provide the video signal for the Teletext decoder input. This is no real problem either, as we will see. In effect, therefore, the basic unit described so far is suitable for 'standard' Teletext reception, but the 'frills' described next month will convert it into a really interesting project.

This leaves us in a quandary. Readers

who want all the 'frills' cannot put the unit into operation until next month; others, who are prepared to do some prospecting inside their set want the calibration procedures and instructions for use now . . . To keep both groups happy, we will describe the calibration for the basic unit now, and include the full 'instructions for use' of the final version. The latter include the description of some options that are not available on the basic unit, but this may serve to whet the appetite!

Basic decoder calibration

Initially, P1, P2 and C9 on the decoder board should all be set to the mid-position. In the input/output circuit, P1 and P3 should be set to maximum; P2 sets the DC level, as indicated in the TV circuit diagram. Hopefully, some kind of Teletext picture should now appear — the picture quality is unimportant at this time. Of the potentiometers in figure 7, P2 sets the sync level, P3 adjusts the video level and P1 sets the gain of the front-end according to the strength of the transmitter.

Proceeding now to the decoder board: this calibration is both simple and critical — strange but true! The 6 MHz oscillator is crystal controlled, which means that the control range of C9 is limited (± 4 kHz). This means that the line frequency (15625 Hz) can never be far off. If a frequency counter is available, the oscillator can be set to exactly 6 MHz when no video signal is applied to the input. A suitable test point is line F6 between pin 6 of IC1 and pin 2 of IC3 (see figure 1).

If the vertical synchronisation is incorrect in Teletext mode (leading to a 'jumpy' picture), this can be corrected by readjusting P1.

The most important adjustment in the whole decoder is L2. This coil must be trimmed up until the decoder synchronises properly on the 'clock-run-in' bytes of the Teletext signal. It is very important for the receiver to be tuned in optimally, in other words that it gives a sharp, clear (colour) picture. After pressing the keys 'reset' and 'TXT-nor' the page header or at least the letters 'P100' will appear on the screen. The core of L2 should be turned until the time indication becomes visible. It will be indicated very clearly within a limited adjustment range and the correct setting for L2 is in the centre of this range. It is best to press the 'reset' key repeatedly during this calibration in order to wipe out the nonsense that the decoder displays on the screen. The decoder should be ready for use now.

Directions for use

TXT-off Fortunately, it is possible to switch off the Teletext decoder. Normally, when the TXT-off-key is operated the TXT picture immediately 'clears the way' for the normal program. However, when this key is pressed during 'mix-mode' the TXT page remains visible for a few seconds before it disappears. After that the TV program can be watched again.

The keys 'full page, half page and reveal' have no effect on the picture in this mode. All the other keys immediately bring about a change in the picture information.

TXT-nor This key activates the decoder which means that the normal mode is selected. The program picture disappears to 'clear the way' for the selected page (see description of the numeric keys).

Mix The program picture doesn't disappear but the Teletext page is displayed on the normal picture. This function can only be reset by the TXT-nor-key or if necessary cancelled via the TXT-off-key. In the latter case the decoder will always return to the mix function when a following key is pressed. Note that this function is not available on the basic decoder.

Numeric keys Page selection is done by pressing a three digit number, this doesn't necessarily require the 'mix-' or 'TXT-nor'-key to be pressed. The page header is displayed in a rectangle on the (normal) screen as soon as a number key is pressed during the 'mix mode' or when the decoder is switched off. The page header remains visible for a few seconds, disappears and returns again when the selected page is received. The decoder indicates the reception by displaying the page number at the upper left of the screen. Time indication will also be visible for a short time. The page is made visible either by pressing the 'TXT-nor' or 'mix'-key.

RESET Generally the first page (P100) consists of search information, for example several references to a more detailed list of contents, therefore this page will often be consulted in order to find a desired page. The 'reset' key returns the page number register to 100 and wipes out the displayed page at the same time, only the page header remains. The counter visible in this header indicates the number of the page being received at that moment. As soon as page 100 appears on the counter the whole screen is written again.

Timed page A page can be selected at a specified time. In order to accomplish this a page number has to be chosen first and then the 'timed-page'-key has to be pressed. At the upper left of the screen T 00.00 will be displayed. The decoder expects the time setting in hours and minutes. At the desired time, the reproduction procedure will operate as described under 'numeric keys'. The 'timed page' function can be cancelled by pressing the same key once more.

Full page/half page The Teletext page consists of rather small letters. In order to improve the readability, it is therefore supplied with the possibility of dividing the page into two pictures. The 'half page'-key selects one half of the page. Repeated operation of this k displays the upper and lower half the enlarged page on the screen, in tur The 'full page' key is operated in orc to reset the page to its normal pr portions again.

Reveal Some Teletext pages contain number of hidden information (f example for video games) which c be made visible by the 'reveal' ke However, this information can only erased by (re-)selecting a page.

Hold Very often the 24 lines of a T page are not enough to display all t information about a certain subje therefore a page can be extended to number of pages. Turning from o page to another is done automatica with the aid of a control bit that transmitted together with the pa Each page is displayed for appro mately 25 seconds. However, if this not long enough it can be held by t HOLD-key so that the decoder will n read any more information. Pressing t HOLD-key activates the decoder aga The decoder may also return to t 'mix-mode' in this case (see nume keys).

Time/B7 Time display is one of t tricks that only expensive TV sets a able to perform. The Teletext decoc enables time to be displayed during normal program. By pressing the ke 'B7' and 'time' simultaneously, time displayed in a rectangle at the upper le of the screen for 5 seconds. If only t key 'time' is pressed either the comple page header will be displayed in a bla rectangle for 5 seconds or the decod will return to 'mix-mode' for the sa period of time.

Sources

- *The history of CEEFAX, S.W. Amo (BBC Engineering)*
- *Broadcast Teletext Specification (BBC, IBA, BREMA)*
- *Mullard Technical Information No. 72: Multitext*
- *Valvo Technical Information No. 800407. Teletext and Viewdat*
- *Valvo development information No. 67: The integrated Video-IF-Amplifier circuit TDA 2541 for TV receiver*
- *Grundig Technical Information 4/5-'80*
- *Siemens Short Form Catalog 1980: Surface Acoustic Wave Filters LIOB®*

speak to your computer

David Ridyard B. Sc.

simple and flexible speech cognition system using an 6800 microprocessor and volving a minimum of external rdware, recognising ten words less than 1.5 seconds, with tter than 90% accuracy. e removal of the key pad terface between man and mputer has many advantages d has long been the pipedream every programmer. By using is M6800 system it can become eality for every home mputer.

Human Speech

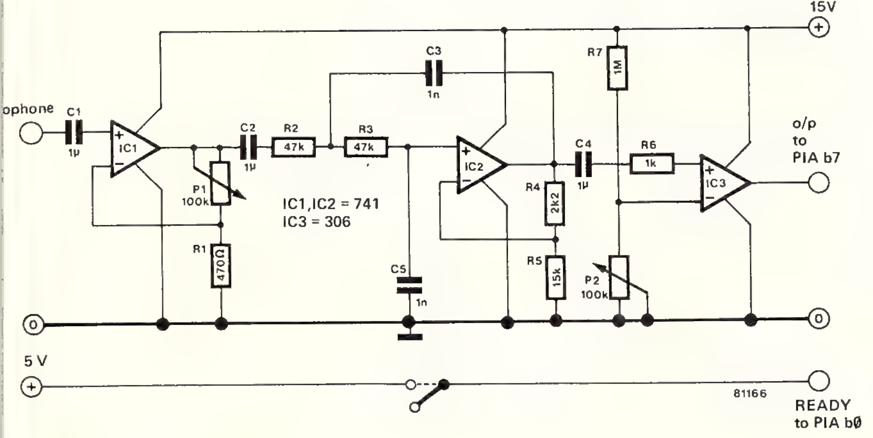
Before describing the techniques employed in this system it is worth briefly considering the production and form of human speech.

The vocal tract can be seen to consist of a d.c. power supply, square wave oscillator and a resonator. The lungs provide a constant air pressure on the back of the taut vocal folds, or vocal chords, which forces these two flaps of skin to open. The Bernouilli forces set up by the air flow then force the folds shut, and the result is a stream of glottal pulses, which may be approximated to a 150 Hz square wave. This means a fundamental at 150 Hz with exponentially decaying odd harmonics at 450 Hz, 750 Hz etc.

The vocal tract itself then acts as a resonator. If it is compared to a perfect closed pipe, 17.5 cm long, resonances would be expected at 500 Hz, 1500 Hz, 2500 Hz and so on. These resonances are known as formants and the form of speech is determined by the position of these formants, which are modulated by the jaw, the tongue, the larynx and the pharynx.

Basic design criteria

Most of the 'word' information is contained in the first three formants, while 'speaker' information is generally contained in the higher formants. Consequently the input signal in this system uses a second order Butterworth filter to band limit the signal to less than 3.8 kHz. This has two advantages. Firstly, it reduces the speed of processing required for analysis and secondly, it means that the response is far less dependant on the speaker's accent.



Work on speech has also shown it is quite intelligible when infinitely clipped, that is to say that zero crossing information is sufficient to characterise a word. This allows us to use a comparator to reduce speech to a single serial bit stream, thus eliminating the need for analogue to digital conversion.

The conventional approach to speech analysis from this point is to perform a Fourier transform, and to look for the positions of formants at various points in the word. However this is clumsy and slow, and so in this system the autocorrelation function has been used:

$$R_X(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{+T} x(t)x(t+\tau)dt$$

This lends itself very easily to microprocessor implementation, when the input x(t) is two valued, and '1' represents +1 and '0' represents −1, since multiplication is performed by the EOR instruction.

The value of τ is determined by the Nyquist frequency for a 4 kHz input, as 0.125 ms. The limits of integration were chosen to cover one full cycle of the lowest frequency of interest, in this case 250 Hz, since the 150 Hz fundamental is uniformly present. This is also convenient since the data required for each autocorrelation uses exactly 4 bytes, plus 4 bytes on either side giving a total of twelve bytes. In order to reduce the memory volume per word, only every fourth set of 12 bytes is used. It may be possible to reduce this further by adjusting the constant value in line 124, $ 24(36), without reducing accuracy. By taking every sixth set, $ 3C(60), a 50% reduction in recognition time would accrue, provided a compatible dictionary is used.

The autocorrelation of the unknown word is compared to the autocorrelation of the words stored in the dictionary, and selection of the answer word is made by the minimum Euclidean distance:

Euclidean distance of answer word = D,

$$D_i = \left[\sum_{K=0}^{n} |X_k - Y_k| \right]_{MIN}$$

n = number of bytes stored per autocorrelated word in store

x_k = k th byte of autocorrelated stored word

y_k = k th byte of autocorrelated spoken word

D_h = distance of h th choice

In order to reduce incorrect decisions a test is done, to see if the second choice word is close to the first choice or not.

$$(D_2 - D_1) \geqslant A$$

Where A is a constant, specified in line 252.

In its present form, the system outputs 5 ASCII characters for the first choice, and 5 for the second choice. If D1 differs significantly from D2, the words 'I THINK . .' appear as a preface to the first choice.

The input routine uses a standard PIA, with the input connected to Bit 7, and the READY line connected to Bit 0.

Filter and comparator design

This circuit consists of three stages, preamp., filter and comparator. The preset P1 could be replaced by a fixed 100 k resistance, but best results are achieved by adjusting P1 to give a maximum peak to peak amplitude of 15 V for normal speech. Conversely R7 and P2 could be omitted, and the comparator reference input tied to earth, but best results are achieved by adjusting P2 to make the output bit stream spend roughly equal amounts of time at '1' and '0'. This reduces false triggering by noise.

Using the existing system

The first thing to do is to create a dictionary, by reading in the ten words required. This is done by taking the Speech Recognition Program, and replacing line 135 with a software interrupt:

```
020F 3F        135:     SWI
```

Words are stored at 2000, 2400, 2800, 2A00 . . . 4400 and the required location is determined by the operand of line 29.

After the READY switch has been switched to 5 V, the system will wait for the first '1' to appear, and will then sample at 8 kHz, for 0.84 seconds; therefore, the speaker should begin to speak the instant that the READY line is put high, and the READY line should be returned to zero as soon as possible after completion of speech.

The five ASCII characters required for output should then be placed at 23D3, 23D4 . . . 23D7 for the word stored at 2000: 27D3 . . . 27D7 for the word at 2400 and so on.

When a complete dictionary of ten words has been read in, the original Speech Recognition Program should be reloaded and run, and the word under test spoken, using the READY switch as before.

The output will consist of the first choice answer on the left and the second choice on the right. As a safety precaution, to ensure incorrect answers do not get through, the threshold in line 252 should be set up. In this case, if the answer word does not satisfy the criterion (3), the words 'I THINK . . .' will appear on the extreme left. Selection of the precise value of the threshold should be made using Graph 1, bearing in mind, that in order to reduce the number of errors, an increase in the number of no decisions will result: 02 or 03 are usually adequate.

Better results can be achieved using a dictionary consisting of words which have been averaged over several utterances of each word (8 in this case). In order to do this, a word should be read in eight times and stored at 2000, 2800, 3000 . . . 5800. The dictionary average program should then be run and the

speech recognition using autocorr.

```
                  1:          NAM               speech recognition using
                                                autocorrelation
0100              2:          ORG     S0100
0100 CE  0004     3: START    LDX     £S0004    start of I/P routine
0103 FF  F508     4:          STX     SF508
0106 B6  F508     5: RDY      LDA A   SF508
0109 2A  FB       6:          BPL     RDY
010B B6  F508     7: ZERO     LDA A   SF508
010E 46           8:          ROR A
010F 24  FA       9:          BCC     ZERO      wait for 1st one
0111 CE  0A00    10:          LDX     £S0A00    first data address
0114 C6  08      11: STORE    LDA B   £8
0116 37          12: LOAD     PSH  B            load B with F508
0117 F6  F508    13:          LDA B   SF508
011A 56          14:          ROR B             put last input bit in carry
011B 49          15:          ROL A             put C in LSB of ACCA
011C C6  IC      16:          LDA B   £S1C
011E 5A          17: WAIT     DEC B             wait for next sample
011F 26  FD      18:          BNE     WAIT
0121 01          19:          NOP
0122 33          20:          PUL  B
0123 5A          21:          DEC B
0124 26  FO      22:          BNE     LOAD
0126 A7  00      23:          STA A   X         8 bits in ACCA?
0128 08          24:          INX
0129 8C  0D48    25:          CPX     £S0D48    840 bytes in store?
012C 26  E6      26:          BNE     STORE     end of input routine
012E 86  12      27:          LDA A   £S12
0130 B7  0426    28:          STA A   S0426     start of auto calcs
0133 CE  1000    29:          LDX     £S1000
0136 FF  0406    30:          STX     S0406
0139 CE  0A00    31:          LDX     £S0A00
013C FF  0420    32:          STX     S0420
013F CE  04E0    33:          LDX     £S04E0
0142 FF  0422    34:          STX     S0422
0145 FF  0424    35:          STX     S0424
0148 C6  OC      36: AUTO     LDA B   £SOC
014A FE  0420    37: MOVE     LDX     S0420
014D A6  00      38:          LDA A   X
014F 08          39:          INX
0150 FF  0420    40:          STX     S0420
0153 FE  0422    41:          LDX     S0422
0156 A7  00      42:          STA A   X         store data at 04E0
0158 08          43:          INX
0159 FF  0422    44:          STX     S0422
015C 5A          45:          DEC B
015D 26  EB      46:          BNE     MOVE
015F CE  0500    47:          LDX     £S0500    set up temp result store address
0162 FF  0400    48:          STX     S0400
0165 FF  0404    49:          STX     S0404
0168 CE  04E0    50:          LDX     £S04E0
016B FF  0402    51:          STX     S0402     set up source data address
016E C6  04      52:          LDA B   £4        take 5th, 6th, 7th & 8th bytes
0170 FE  0402    53: LOOP 1   LDX     S0402     of 12 data bytes
0173 37          54:          PSH  B
0174 C6  08      55:          LDA B   £8
0176 A6  00      56: LOOP 2   LDA A   X
0178 A7  10      57:          STA A   S10,X     move 8 bytes corresponding to
017A 08          58:          INX
017B 5A          59:          DEC B
017C 26  F8      60:          BNE     LOOP 2
017E FE  0402    61:          LDX     S0402
0181 C6  38      62:          LDA B   £S38      56 (S38) 1-bit shift moves
0183 A6  04      63: LOOP 3   LDA A   4,X       12 bytes across 4 bytes
0185 A8  10      64:          EDR A   S10,X
0187 43          65:          COM A             multiplies input by input
0188 66  17      66:          ROR     S17,X     shifted in time
018A 66  16      67:          ROR     S16,X
018C 66  15      68:          ROR     S15,X
018E 66  14      69:          ROR     S14,X
0190 66  13      70:          ROR     S13,X
0192 66  12      71:          ROR     S12,X
0194 66  11      72:          ROR     S11,X
0196 66  10      73:          ROR     S10,X
0198 FF  0402    74:          STX     S0402
019B FE  0400    75:          LDX     S0400
019E A7  80      76:          STA A   S80,X     stores temp result at every 4th
01A0 08          77:          INX               location from S0580
01A1 08          78:          INX
01A2 08          79:          INX
01A3 08          80:          INX
01A4 FF  0400    81:          STX     S0400
01A7 FE  0402    82:          LDX     S0402
01AA 5A          83:          DEC B
01AB 26  D6      84:          BNE     LOOP 3
01AD 20  02      85:          BRA     ISLE      long branch island
01AF 20  97      86: AUTC     BRA     AUTO
01B1 08          87: ISLE     INX
01B2 FF  0402    88:          STX     S0402
01B5 FE  0404    89:          LDX     S0404
01B8 08          90:          INX
01B9 FF  0400    91:          STX     S0400
01BC FF  0404    92:          STX     S0404
01BF 33          93:          PUL B
01C0 5A          94:          DEC B
01C1 26  AD      95:          BNE     LOOP 1
01C3 CE  0580    96:          LDX     £S0580
01C6 C6  38      97:          LDA B   £S38
01C8 37          98: LOOP 4   PSH  B
01C9 4F          99:          CLR A
01CA C6  20     100:          LDA B   £S20
01CC 66  00     101: LOOP 5   RDR     X         adds up no. of 1's
01CE 66  01     102:          ROR     1,X       in each group of 4 temp results
01D0 66  02     103:          ROR     2,X
01D2 66  03     104:          ROR     3,X
01D4 89  00     105:          ADC A   £0
01D6 5A         106:          DEC B
01D7 26  F3     107:          BNE     LOOP 5
```

```
D9 08         108:         INX
DA 08         109:         INX
DB 08         110:         INX
DC 08         111:         INX
DD FF  0408   112:         STX     S0408
E0 FE  0406   113:         LDX     S0406
E3 A7  00     114:         STA A   X          store results @ S1000+ . . .
E5 08         115:         INX
E6 FF  0406   116:         STX     S0406
E9 FE  0408   117:         LDX     S0408
EC 33         118:         PUL B
ED 5A         119:         DEC B
EE 26  D8     120:         BNE     LOOP 4
F0 FF  0408   121:         STX     S0408
F3 FE  0420   122:         LDX     S0420
F6 37         123:         PSH  B             take only every 4th 12 bytes
F7 C6  24     124:         LDA B   £S24
F9 08         125: ALT     INX
FA 5A         126:         DEC B
FB 26  FC     127:         BNE     ALT
FD 33         128:         PUL  B
FE FF  0420   129:         STX     S0420
01 FE  0424   130:         LDX     S0424
04 FF  0422   131:         STX     S0422
07 FE  0408   132:         LDX     S0408
0A 7A  0426   133:         DEC     S0426
0D 26  AO     134:         BNE     AUTC
0F CE  2000   135:         LDX     £S2000
12 FF  1A00   136:         STX     S1A00
15 CE  2400   137:         LDX     £S2400     initialise dic. addresses
18 FF  1A02   138:         STX     S1A02
1B CE  2800   139:         LDX     £S2800
1E FF  1A04   140:         STX     S1A04
21 CE  2C00   141:         LDX     £S2C00
24 FF  1A06   142:         STX     S1A06
27 CE  3000   143:         LDX     £S3000
2A FF  1A08   144:         STX     S1A08
2D CE  3400   145:         LDX     £S3400
30 FF  1A0A   146:         STX     S1A0A
33 CE  3800   147:         LDX     £S3800
36 FF  1A0C   148:         STX     S1A0C
39 CE  3C00   149:         LDX     £S3C00
3C FF  1A0E   150:         STX     S1A0E
3F CE  4000   151:         LDX     £S4000
42 FF  1A10   152:         STX     S1A10
45 CE  4400   153:         LDX     £S4400
48 FF  1A12   154:         STX     S1A12
4B CE  1800   155:         LDX     £S1800
4E FF  1B06   156:         STX     S1B06      set up answer storage
51 C6  0A     157:         LDA B   £S0A       start of cross-correlation
53 86  FF     158:         LDA A   £SFF
55 A7  02     159:         STA A   2,X
57 A7  03     160:         STA A   3,X
59 A7  04     161:         STA A   4,X
5B A7  05     162:         STA A   5,X
5D CE  19FE   163:         LDX     £S19FE
60 FF  1B00   164:         STX     S1B00
63 CE  1000   165: CROSS   LDX     £S1000
66 FF  1B04   166:         STX     S1B04      initialise dictionary address
69 FE  1B00   167:         LDX     S1B00
6C 08         168:         INX
6D 08         169:         INX
6E FF  1B00   170:         S1B00
71 EE  00     171:         LDX     X          initialise dic. addresses
73 FF  1B02   172:         STX     S1B02      ~~initialise dic. addresses~~
76 37         173:         PSH B
77 FE  1B06   174:         LDX     S1B06
7A 4F         175:         CLR A
7B A7  00     176:         STA A   X
7D A7  01     177:         STA A   1,X
7F CE  04D3   178:         LDX     £S04D3
82 FF  1900   179:         STX     S1900
85 FE  1B04   180: SUBT    LDX     S1B04
88 A6  00     181:         LDA A   X          load ACCA with word value
8A 08         182:         INX
8B FF  1B04   183:         STX     S1B04
8E FE  1B02   184:         LDX     S1B02
91 AO  00     185:         SUB  A  X          subtract dic. value
93 2A  02     186:         BPL     PLUS
95 4A         187:         DEC  A             take modulus
96 43         188:         COM A
97 08         189: PLUS    INX
98 FF  1B02   190:         STX     S1B02
9B FE  1B06   191:         LDX     S1B06
9E AB  00     192:         ADD A   X          add to running total
A0 A7  00     193:         STA  A  X
A2 24  02     194:         BCC     NOVE
A4 6C  01     195:         INC     1,X
A6 7A  1901   196: NOVE    DEC     S1901
A9 26  DA     197:         BNE     SUBT
AB 7A  1900   198:         DEC     S1900
AE 26  D5     199:         BNE     SUBT
B0 A6  03     200:         LDA A   3,X        compare MSB of first choice
B2 A1  01     201:         CMP A   1,X
B4 22  0A     202:         BHI     NANS
B6 26  26     203:         BNE     RUNUP
B8 A6  02     204:         LDA A   2,X        compare LSB
BA A1  00     205:         CMP A   0,X
BC 22  02     206:         BHI     NANS
BE 20  1E     207:         BRA     RUNUP
C0 A6  02     208: NANS    LDA A   2,X        substitute new first and
C2 A7  04     209:         STA  A  4,X        second choices.
C4 A6  03     210:         LDA A   3,X
C6 A7  05     211:         STA  A  5,X
C8 A6  00     212:         LDA A   0,X
CA A7  02     213:         STA  A  2,X
CC A6  01     214:         LDA A   1,X
CE A7  03     215:         STA  A  3,X
D0 FE  1B08   216:         LDX     S1B08
D3 FF  1B0A   217:         STX     S1B0A
```

```
02D6 FE  1B02   218:         LDX     S1B02
02D9 FF  1B08   219:         STX     S1B08
02DC 20  1E     220:         BRA     SANS
02DE A6  05     221: RUNUP   LDA A   5,X        compare MSB of second choice
02E0 A1  01     222:         CMP A   1,X
02E2 22  0A     223:         BHI     NAN2
02E4 26  16     224:         BNE     SANS
02E6 A6  04     225:         LDA A   4,X
02E8 A1  00     226:         CMP A   0,X        compare LSB of second choice
02EA 22  02     227:         BHI     NAN2
02EC 20  0E     228:         BRA     SANS
02EE A6  00     229: NAN2    LDA A   0,X        substitute new second choice
02F0 A7  04     230:         STA A   4,X
02F2 A6  01     231:         LDA A   1,X
02F4 A7  05     232:         STA A   5,X
02F6 FE  1B02   233:         LDX     S1B02
02F9 FF  1B0A   234:         STX     S1B0A
02FC 33         235: SANS    PUL B
02FD 5A         236:         DEC B
02FE 26  05     237:         BNE     JUMP
0300 BD  EOCC   238:         JSR     SEOCC
0303 20  03     239:         BRA     OUT
0305 7E  0263   240: JUMP    JMP     CROSS
0308 86  0A     241: OUT     LDA A   £S0A       line feed
030A BD  E1D1   242:         JSR     SE1D1
030D 86  0D     243:         LDA A   £S0D       carriage return
030F BD  E1D1   244:         JSR     SE1D1
0312 B6  1805   245:         LDA A   S1805      load A with MSB of 2nd choice
0315 B0  1803   246:         SUB  A  S1803      subtract MSB of 1st choice
0318 B7  5000   247:         STA  A  S5000
031B BD  E067   248:         JSR     SE067
031E B6  5000   249:         LDA A   S5000
0321 BD  E06B   250:         JSR     SE06B
0324 B6  5000   251:         LDA A   S5000
0327 81  00     252:         CMP  A  £S00       compare with threshold
0329 24  37     253:         BCC     OK
032B 86  20     254:         LDA A   £S20       output 'I THINK' if bad answer
032D BD  E1D1   255:         JSR     SE1D1
0330 86  2E     256:         LDA A   £S2E
0332 BD  E1D1   257:         JSR     SE1D1
0335 86  2E     258:         LDA A   £S2E
0337 BD  E1D1   259:         JSR     SE1D1
033A 86  2E     260:         LDA A   £S2E
033C BD  E1D1   261:         JSR     SE1D1
033F 86  49     262:         LDA A   £S49
0341 BD  E1D1   263:         JSR     SE1D1
0344 86  20     264:         LSA A   £S20
0346 BD  E1D1   265:         JSR     SE1D1
0349 86  74     266:         LDA A   £S74
034B BD  E1D1   267:         JSR     SE1D1
034E 86  68     268:         LDA A   £S68
0350 BD  E1D1   269:         JSR     SE1D1
0353 86  69     270:         LDA A   £S69
0355 BD  E1D1   271:         JSR     SE1D1
0358 86  6E     272:         LDA A   £S6E
035A BD  E1D1   273:         JSR     SE1D1
035D 86  6B     274:         LDA A   £S6B
035F BD  E1D1   275:         JSR     SE1D1
0362 FE  1B08   276: OK      LDX     S1B08
0365 A6  00     277:         LDA A   S00,X      output answer word
0367 BD  E1D1   278:         JSR     SE1D1
036A A6  01     279:         LDA A   1,X
036C BD  E1D1   280:         JSR     SE1D1
036F A6  02     281:         LDA A   2,X
0371 BD  E1D1   282:         JSR     SE1D1
0374 A6  03     283:         LDA A   3,X
0376 BD  E1D1   284:         JSR     SE1D1
0379 A6  04     285:         LDA A   4,X
037B BD  E1D1   286:         JSR     SE1D1
037E A6  05     287:         LDA A   5,X
0380 BD  E1D1   288:         JSR     SE1D1
0383 BD  EOCC   289:         JSR     SEOCC
0386 86  28     290:         LDA A   £S28       output 2nd choice
0388 BD  E1D1   291:         JSR     SE1D1
038B FE  1B0A   292:         LDX     S1B0A
038E A6  00     293:         LDA A   0,X
0390 BD  E1D1   294:         JSR     SE1D1
0393 A6  01     295:         LDA A   1,X
0395 BD  E1D1   296:         JSR     SE1D1
0398 A6  02     297:         LDA A   2,X
039A BD  E1D1   298:         JSR     SE1D1
039D A6  03     299:         LDA A   3,X
039F BD  E1D1   300:         JSR     SE1D1
03A2 A6  04     301:         LDA A   4,X
03A4 BD  E1D1   302:         JSR     SE1D1
03A7 A6  05     303:         LDA A   5,X
03A9 BD  E1D1   304:         JSR     SE1D1
03AC 86  29     305:         LDA A   £S29
03AE BD  E1D1   306:         JSR     SE1D1
03B1 7E  0106   307:         JMP     RDY        wait for next word
03B4 3F         308:         SWI
                309:         END
```

```
symbol table:
ALT     01F9   AUTO    01AF   AUTO    0148   CROSS   0263
ISLE    01B1   JUMP    0305   LOAD    0116   LOOP1   0170
LOOP2   0176   LOOP3   0183   LOOP4   01C8   LOOP5   01CC
MOVE    014A   NAN2    02EE   NANS    02C0   NOVE    02A6
OK      0362   OUT     0308   PLUS    0297   RDY     0106
RUNUP   02DE   SANS    02FC   START   0100   STORE   0114
SUBT    0285   WAIT    011E   ZERO    010B
```

dictionary average program

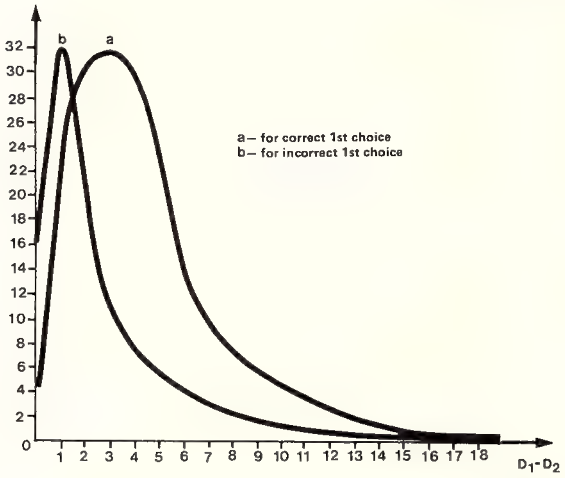
```
                     1:         NAM              dictionary average program
0100                 2:         ORG     S0100
0100  CE  1000       3:         LDX     £S1000   set up input word data address
0103  FF  1A00       4:         STX     S1A00
0106  CE  2000       5:         LDX     £S2000
0109  FF  1A02       6:         STX     S1A02
0100  CE  2800       7:         LDX     £S2800
010F  FF  1A04       8:         STX     S1A04
0112  CE  3000       9:         LDX     £S3000
0115  FF  1A06      10:         STX     S1A06
0118  CE  3800      11:         LDX     £S3800
011B  FF  1A08      12:         STX     S1A08
011E  CE  4000      13:         LDX     £S4000
0121  FF  1A0A      14:         STX     S1A0A
0124  CE  4800      15:         LDX     £S4800
0127  FF  1A0C      16:         STX     S1A0C
012A  CE  5000      17:         LDX     £S5000
012D  FF  1A0E      18:         STX     S1A0E
0130  CE  5800      19:         LDX     £S5800
0133  FF  1A10      20:         STX     S1A10
0136  CE  1800      21:         LDX     £S1800   intermediate data address
0139  FF  1A12      22:         STX     S1A12
013C  FF  1A14      23:         STX     S1A14
013F  CE  08A7      24:         LDX     £S08A7
0142  FF  1A16      25:         STX     S1A16    number of bytes to compute
0145  FE  1A14      26:  AVRG   LDX     S1A14
0148  FF  1A12      27:         STX     S1A12
014B  FE  1A02      28:         LDX     S1A02
014E  A6  00        29:         LDA A   X
0150  08            30:         INX
0151  FF  1A02      31:         STX     S1A02    move first data word to
0154  FE  1A12      32:         LDX     S1A12    intermediate address
0157  A7  00        33:         STA A   X
0159  08            34:         INX
015A  FF  1A12      35:         STX     S1A12
015D  FE  1A04      36:         LDX     S1A04
0160  A6  00        37:         LDA A   X
0162  08            38:         INX
0163  FF  1A04      39:         STX     S1A04
0166  FE  1A12      40:         LDX     S1A12
0169  A7  00        41:         STA A   X
016B  08            42:         INX
016C  FF  1A12      43:         STX     S1A12
016F  FE  1A06      44:         LDX     S1A06
0172  A6  00        45:         LDA A   X
0174  08            46:         INX
0175  FF  1A06      47:         STX     S1A06
0178  FE  1A12      48:         LDX     S1A12
017B  A7  00        49:         STA A   X
017D  08            50:         INX
017E  FF  1A12      51:         STX     S1A12
0181  FE  1A08      52:         LDX     S1A08
0184  A6  00        53:         LDA A   X
0186  08            54:         INX
0187  FF  1A08      55:         STX     S1A08
018A  FE  1A12      56:         LDX     S1A12
018D  A7  00        57:         STA A   X
018F  08            58:         INX
0190  FF  1A12      59:         STX     S1A12
0193  FE  1A0A      60:         LDX     S1A0A
0196  A6  00        61:         LDA A   X
0198  08            62:         INX
0199  FF  1A0A      63:         STX     S1A0A
019C  FE  1A12      64:         LDX     S1A12
019F  A7  00        65:         STA A   X
01A1  08            66:         INX
01A2  FF  1A12      67:         STX     S1A12
01A5  FE  1A0C      68:         LDX     S1A0C
01A8  20  02        69:         BRA     SKIP     long branch island
01AA  20  99        70:  AVGE   BRA     AVRG
01AC  01            71:  SKIP   NOP
01AD  A6  00        72:         LDA A   X
01AF  08            73:         INX
01B0  FF  1A0C      74:         STX     SLAOC
01B3  FE  1A12      75:         LDX     S1A12
01B6  A7  00        76:         STA A   X
01B8  08            77:         INX
01B9  FF  1A12      78:         STX     S1A12
01BC  FE  1A0E      79:         LDX     S1A0E
01BF  A6  00        80:         LDA A   X
01C1  08            81:         INX
01C2  FF  1A0E      82:         STX     S1A0E
01C5  FE  1A12      83:         LDX     S1A12
01C8  A7  00        84:         STA A   X
01CA  08            85:         INX
01CB  FF  1A12      86:         STX     S1A12
01CE  FE  1A10      87:         LDX     S1A10
01D1  A6  00        88:         LDA A   X
01D3  08            89:         INX
01D4  FF  1A10      90:         STX     S1A10
01D7  FE  1A12      91:         LDX     S1A12
01DA  A7  00        92:         STA A   X
01DC  08            93:         INX
01DD  FF  1A12      94:         STX     S1A12
01E0  CE  1800      95:         LDX     £S1800
01E3  4F            96:         CLR A
01E4  AB  00        97:         ADD A   X
01E6  AB  01        98:         ADD A   1,X      add up 8 data words
01E8  AB  02        99:         ADD A   2,X
01EA  AB  03       100:         ADD A   3,X
01EC  AB  04       101:         ADD A   4,X
01EE  AB  05       102:         ADD A   5,X
01F0  AB  06       103:         ADD A   6,X
01F2  AB  07       104:         ADD A   7,X
01F4  46           105:         ROR A            divide by eight
01F5  47           106:         ASR A
01F6  47           107:         ASR A
01F7  CE  1A00     108:         LDX     £S1A00
01FA  A7  00       109:         STA A   X
01FC  08           110:         INX
01FD  FF  1A00     111:         STX     S1A00
0200  7A  1A17     112:         DEC     S1A17    have we finished?
0203  26  A5       113:         BNE     AVGE
0205  7A  1A16     114:         DEC     S1A16
0208  26  A0       115:         BNE     AVGE
020A  CE  1000     116:         LDX     £S1000
020D  FF  1A00     117:         STX     S1A00
0210  CE  2000     118:         LDX     £S2000   output address
0213  FF  1A02     119:         STX     S1A02
0216  CE  08A7     120:         LDX     £S08A7
0219  FF  1900     121:         STX     S1900
021C  FE  1A00     122:  MOVE   LDX     S1A00
021F  A6  00       123:         LDA A   X
0221  08           124:         INX
0222  FF  1A00     125:         STX     S1A00
0225  FE  1A02     126:         LDX     S1A02
0228  A7  00       127:         STA A   X
022A  08           128:         INX
022B  FF  1A02     129:         STX     S1A02
022E  7A  1901     130:         DEC     S1901
0231  26  E9       131:         BNE     MOVE
0233  7A  1900     132:         DEC     S1900
0236  26  E4       133:         BNE     MOVE
0238  3F           134:         SWI
                   135:         END
no error(s) detected
symbol table:
AVGE   01AA   AVRG   0145   MOVE   021C   SKIP   01AC
```

output address determined by the operand of line 118. Do not forget to add in your five ASCII characters, as before. Doing this ten times is a relatively slow and laborious process, involving a lot of work loading and altering programs from disc or tape but a significant improvement in results is noted, and once a dictionary is completed it can be used indefinitely.

Without using the threshold, but with an averaged dictionary, 90% accuracy should be achieved for all speakers of the same sex. Using a threshold of 02, the errors are reduced to only 4% or less, while the decision rate falls to 81%. Roughly double these errors will occur if an averaged dictionary is not used.

Initially a new speaker, not used to timing the switch properly, and over emphasising his speech may achieve less than 70%, but after a few runs through the dictionary he will improve to almost the same standard as the original author of the dictionary.

2



Graph 1. relative occurance frequency of distances between first and second choice answers.

81166

fortunately, almost no success has ɜn achieved in using male speakers d a female author or vice versa, hough occasionally a freak set of ults can occur, when a female speaks exactly one octave above the male.

dapting the existing system

e first variable is the decision eshold, in line 252, which has already ɜn dealt with in some detail.

e next thing the user may wish to do, to extend the dictionary. The number words is determined by the operand line 157. In order to accomodate ch extra word, two lines must be erted between lines 154 and 155, in ch a manner as to suitably extend the quence, which should be obvious from es 135 to 154; i.e. for the eleventh ɪrd:

```
154.1:    LDX    £$ 4800
154.2:    STX     $ 1A14
```

e most important alterations which a r may wish to perform, concern the tput. The existing system uses the B subroutine, which outputs the CII character stored in the A accumu- or. If this does not exist, a similar utine must be written, and placed $ E1D1.

e next alteration may be to ask the eaker to 'REPEAT', if the criterion 3 not satisfied. This is simply done by ering the ASCII characters in lines 4, 256, 258 etc. from 'I THINK' to EPEAT'. At the end of this output ction a branch back to line 3, should entered.

ie output of the first and second oice relies on the fact that the address the first ASCII character of the first oice is stored at $ 1B08, and the first SCII character of the second choice is ɔred at $ 1B0A. These addresses could used as the target addresses for anch instructions, to cause the system perform whatever function is quired.

ing the characters 0 to 7, and the ɔrds 'WRITE' and 'STOP', octal ogramming should only require atively simple subroutines, as should ntrolling train sets or remote control T.V. sets. The latter two applications particularly good, since an oc- sional error would not be fatal.

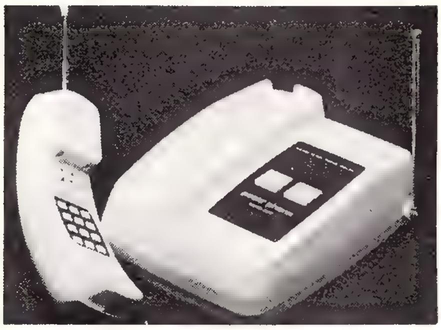
cknowledgements

ie author would like to offer thanks, r the time and equipment lent to m by the University of Durham, partment of Applied Physics and ectronics, especially Dave Isaacs and . Tim Spracklen.

market

Secure cordless phone

Known as 'The Handshake', the digital accessing facility from Pace Electronics (UK) eliminates the security risks which have faced manufacturers of cordless phones. 'The Handshake' is a means of providing digital access between the handset and the base station thus offering total security to the phone user. Up to now the major problem of cordless phones has been the ability — albeit inadvertently — to dial out using a neighbour's phone line.



The success of the digital accessing developed by Pace Electronics has been achieved by inserting a security circuit which inhibits the line relay until a decoded train of digits from 'The Handshake' has been compared with a pre-selected code or number of digits. Upon successful comparison — and only if a successful comparison has been achieved — the line relay is reinstated back into the circuit which then facilitates normal dialling.

There are five different Pacer models available on the market with operational ranges from the base unit from 100 yards to half a mile.

Pace Electronics (U.K.),
PO Box 27,
Havant, Hants, PO9 1QX.
Telephone: (0705) 453333

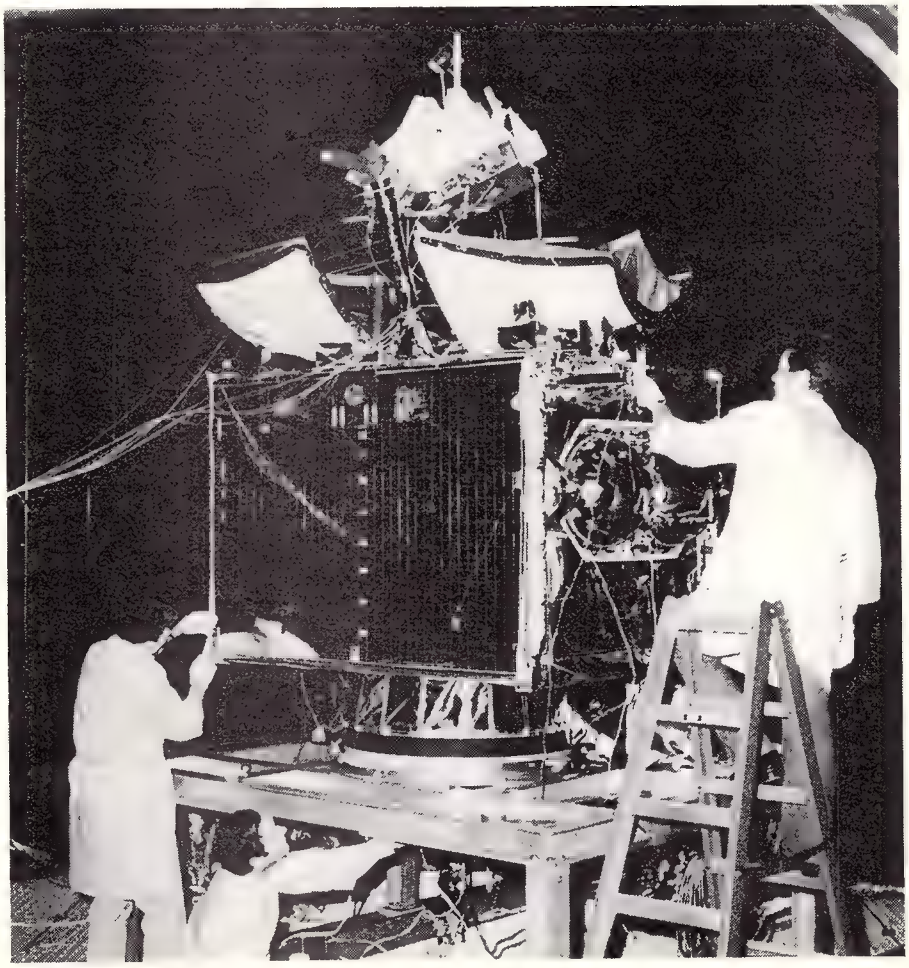
(2133 M)

Hook-up in an RCA space chamber

Technicians at RCA Astro-Electronics, Princeton, N.J., prepare the RCA Satcom III-R communications satellite for a series of tests in a giant thermal/vacuum chamber, The tests assure that the spacecraft can operate reliably in the vacuum and extreme temperatures of earth orbit. Scheduled for launching in late 1981, the satellite will provide communications for all 50 states. Owned and operated by RCA American Communications Inc., Princeton, RCA Satcom satellites serve the cable TV industry as well as provide commercial and government services.

RCA Astro-Electronics,
Princeton,
NJ, U.S.A.
Telephone: 08540-(609) 448-3400, Ext. 2966

(2136 M)

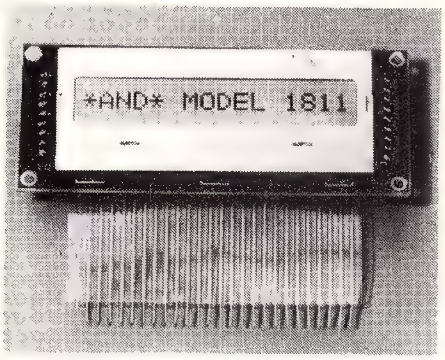


market

Dot matrix LCD module

The AND 1811 features 16 alphanumeric characters. Each 5 x 7 dot matrix character is 0.17" high and is capable of displaying the full ASCII character set. Display drivers which store and update the dot information for all 16 characters are included in the dual PC board design. Mounting of the liquid crystal display is accomplished with elastomer connectors and a sturdy, metallic bezel. The entire unit, excluding the attached ribbon cable leads, measures a compact 3.66" (W) x 1.5" (H) x 0.57" (D).

Like all AND liquid crystal dot matrix display modules, the ABD 1811 only requires a single 5 volt DC supply for operation. Additional features include wide 0 to 50°C operating temperature range, low power consumption, and CMOS/TTL compatible interfaces.



The display is intended for use in hand-held terminals, microcomputer terminals, phone set message displays, and message displays for measurement, test and analytical instruments, and is available with a red, green, or blue display as well as the standard black.

Semiconductor Specialists (UK) Limited,
Carroll House,
159 High Street,
Yiewsley,
West Drayton,
Middlesex UB7 7XB.
Telephone: 08954.45522/46415

(2108 M)

Computer software test instrument

A new unique test instrument which provides computer and transmission line service engineers with full workshop facilities packages into a neat hand held unit is now available from Hallashire Technical Services Limited of Sheffield.

This new instrument, called the TERMITESTER provides the service engineer with the full on-site test facilities which until now have only been available in a service workshop. Available in two versions it provides all the various types of test signals required to evaluate and 'trouble-shoot' VDU's, printers, keyboards, communications devices and transmission lines by generating or monitoring RS232 EIA or 20 mA current loop signals.

The TERMITESTER provides all of the following test functions which are switch selected. LED displays signal circuit status. Full ASCII test sequence can be generated repeatedly or on a line-by-line basis. Any single character signal can be generated — a useful coding chart to aid character selection is incorporated into the instrument's protective lid. Monitoring EIA Control signals presented to a terminal by a line or to the line by a terminal. Superimposition of any or all control signals. Internal test and 'transparent' signal evaluation on data lines. 'Echo' keyboard character capability.

When operating on current loop the instrument can be used with either self supplying transmissions or an external current source. Baud speed switch selectable from 100 to 9600 bps for greater versatility.

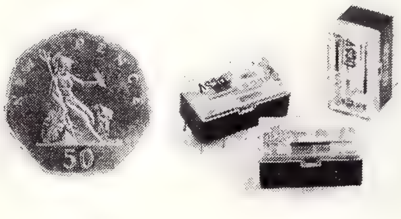
The TERMITESTER has a robust fold-up lid to protect it when not in use and measures 5in x 6in. It will therefore, fit easily into virtually any service kit. Power is supplied by 'AA.' type dry cells, or rechargeable cells with a mains power pack, available as an optional extra.

Hallamshire Technical Services Limited,
11, Union Road,
Sheffield, S11 9EF.
Telephone: 0298 5888

(2105 M)

TTL compatible relays

IMO Precision Controls have added the TTL compatible relay, type G2V2, to their range



of OMRON printed circuit board relays, meet the requirements of the communicati
and alarm industries.

The G2V2 series have twin bifurcated c
tacts constructed of gold clad silver palladi
and wide switching capacity from 10 µA
2 A.

The low coil resistance of 56 ohms (
model) and wide operating voltage of 70-1
per cent make it an ideal interface for co
munications and alarm applications.

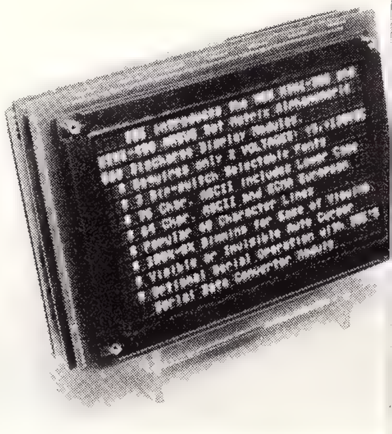
Standard models are available in 5 V DC
48 V DC operating voltages and sealed
sions can also be supplied. The G2V2 rel
are ex stock from IMO.

IMO Precision Controls Ltd.,
349 Edgware Road,
London W2 1BS.
Telephone: 01 723 2231

(2102

Neon plasma displays

The Industrial Products Division of Indust
Electronic Engineers, Inc., has introduce
series of neon plasma displays with swi
selectable fonts, model numbers 3401-XX-
and 3401-XX-480. The character fonts
contained in a 2K x 8 EPROM (2716). Up
four fonts can be addressed from a
switch. Standard fonts include 64-charac
English, 64-character European and 96-char
ter English with upper and lower case char
ters. Characters are formed in a 5 x 7
matrix, model 3401-XX-320 has 8 lines
40 characters and model 3401-XX-480



12 lines of 40 characters per line. Data
transferred serially up to 100 bits per seco
in either 6-bit or 7-bit ASCII. The 3401 ser
require only two voltages, 5 V DC at 1600
and 150 V DC at 185 mA.

IEE,
7740 Lemona Avenue,
Van Nuys,
California, 91405.
Telephone: (213) 787-0311, ext. 210

(2110

:roscopes

umber of very useful pocket sized micro-
ɪes are available from Gemdata. They are
plete with operating instructions and
vidually boxed. The unique features of
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V batteries. There are separate focussing
zoom controls on the microscope and a
rt black plastic case is supplied with it.
nification 30x - 50x.

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penlight batteries
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30 x — 50 x

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ckel plated
gnification 100 x

odel 461 A
cket
croscope/telescope
ld anodised
gnification telescope 8 x
microscope 30 x

model 461-A pocket microscope/tele-
pe is a useful dual purpose instrument
ch can be used either as a microscope or a
scope and it is extremely simple to
rate. The unit has an attractive gold
dised finish. Magnification - telescope 8x,
roscope 30x.

model M80 pocket microscope is a very
ipact unit with an attractive nickel plated
sh. Magnification 80x.

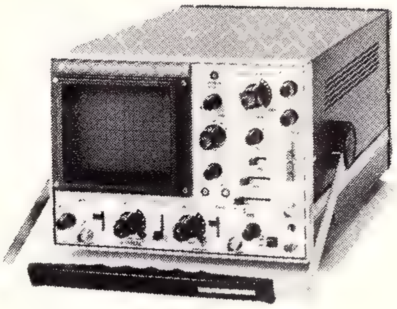
ndata Limited,
Broad Lane,
don N15 4DE.
phone: 01-808-0447/801-9658.

(2131 M)

MHz dual trace oscilloscope th delayed sweep

ıse of Instruments announce another new
lloscope from Trio. The CS1820 is an
ant solution to the problems of high speed
eform observations at a low cost. Fea-
ng a high resolution display, usable to all
r corners of its 140 mm rectangular, post-
elerator type 16KV CRT. A graduated
er face eliminates parallax errors and
vides sharp bright pictures of high fre-
ncy and fast rising signals.

gger delay, for delayed sweep display, the
to observing complex waveforms, first
d in the current and very successful
1830 is again employed in the CS 1820 to
w observation and analysis of any delayed
ion of a waveform. In addition, with B



sweep not locked into the delayed sweep function any combination of A and B sweeps may be selected. This system is extremely efficient in the detailed examination of high speed digital or video signals.

The CS 1820 oscilloscope includes 2 mV to 5 V/div sensitivity — 0.2 microsec to 0.5 s/div sweep times plus X5 MAG — a video sync. separator for both horizontal and vertical signals, variable hold off for stable observation of complex periodic signals, alternate and chop modes, auto free run triggering, add and subtract modes, high sensitivity X-Y operation, TTL Z modulation and a signal delay line.

Fully guaranteed for 2 years, including pick up and return, the CS 1820 weighs 8.6 kg and measures 260 x 190 x 375 mm. Price £420 (excluding P & D and VAT). 100 MHz X1, X10 switchable probes are available with the oscilloscope at a special price of £ 7.00 each.

House of Instruments,
34/36 High Street,
Saffron Walden,
Essex, CB10 1EP.
Telephone: (0799) 24922
Telex: 81653.

(2137 M)

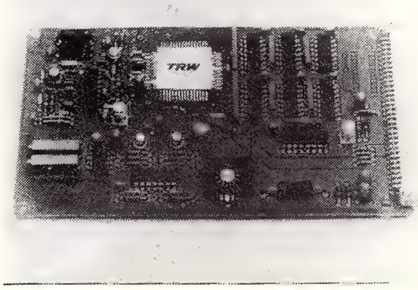
TRW LSI introduces new 1-micro geometry A/D converter

A new 8-bit A/D Converter Board from TRW LSI Products is now available from MCP Electronics.

Listed as the TDC1025E1C, this latest A/D converter is designed to operate at 75 megasamples/sec and embodies a single chip, 1-micron geometry, triple-diffused (3D) 'flash' converter mounted on a 100 x 160 mm board and capable of accepting analog input signals with a 20 MHz bandwidth and supplying the corresponding 8-bit digital output.

The CONVERT signal and the 8-bit binary outputs are buffered single ended ECL.

Full scale analog input ranges of 1 to 10 V can be selected using on-board resistors which also select input impedances of 50 to 1 K ohms, and offset adjustments are provided for single or bipolar inputs.



Supply voltages are ± 15 V and —5.2 V with the ± 15 V supplies being used to obtain a regulated —2 V references: —6 V for the 'flash' converter chip and +5 V for the internal buffers. Total power dissipation is about 2 W.

For further details, contact

MCP Electronics Limited,
38 Rosemont Road, Alperton,
Wembley, Middlesex, HA0 4PE.
Telephone: (01) 902 6146.

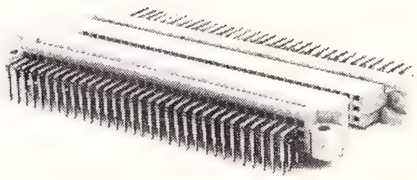
(2134 M)

New DIN-standard connector

Ultra Electronic Components Limited have introduced the first types in their new range of two-part printed circuit board connectors. Designated the Series 1696, these are totally manufactured in the U.K. to conform to both BS 9525 and DIN 41612 Standards.

The Series consists of two part assemblies moulded in flame-retardent and solvent-resistant glass-filled polyester. These incorporate contacts inlaid with gold on the mating surfaces, a technique which reduces costs over fully or selectively plated contacts and results in a particularly cost-effective design.

Two and three row types, with 32 contact cavities per row, are available with 16, 32, 48, 64 or 96 contacts as standard. Gold inlay thicknesses can be specified as 0.5, 1.0, 1.9 or 3.0 μm, and contact pitch is selectable at either 2.54 mm (0.1") or 5.08 mm (0.2"). The female sockets have twin cantilever contacts for reliability, and premating earthing contacts are available on the male connectors if required.



Mechanical endurance (engaging and separating) will exceed 500 operations with 3.0 μm gold inlaid contacts, and the operating temperature range is — 55° to +125°C. Contact resistance (after conditioning) is a maximum of 20 milliohms.

Ultra Electronic Components Ltd.,
Fassetts Road,
Loudwater, High Wycombe,
Bucks HP10 9UT.
Telephone: 0494-26233

(2135 M)

Book 2 in The Junior Computer Series

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This, the second in the Junior Computer Book series, follows in a logical continuation of book 1 and is an indispensible aid to users of the Junior Computer.

The book contains a detailed appraisal of the software. Three major programming tools, the monitor, an assembler and an editor are discussed in detail together with practical proposals for input output and peripherals. The complete source listing with relevant comments for all described programs, and the entire contents of the EPROM, are included.

THE JUNIOR COMPUTER BOOK 2 IS AVAILABLE NOW from

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(After all, with eight years of experience, we ought to know how to do the job properly!) The current list contains over **200** of them, all different and with a project to match. No 35 is the stand where electronics is a way of life and definitely out of the rut. Where else will you find:

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that's why it's called

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Sinclair ZX81 Personal Com
the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
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- Randomise function – useful for games as well as serious applications.
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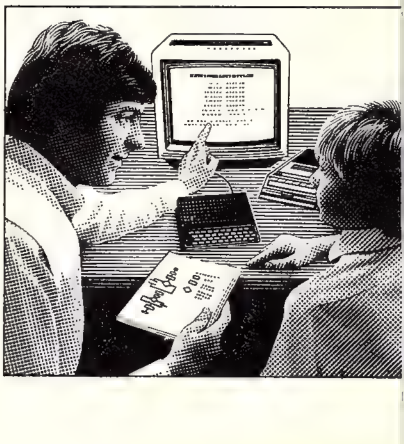
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips t assemble (plus, of course the othe discrete components) – a few hou work with a fine-tipped soldering i And you may already have a suitab mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied wit built version).

Kit and built versions come co plete with all leads to connect to your TV (colour or black and white) and cassette recorder.



ter-

```
10 FOR I=1 TO 22
20 PRINT "/"
30 NEXT I
40 PRINT AT 10,0;"--------------------------------"
50 FOR I=0 TO 63
60 PLOT I,22+20*SIN (I/32*PI)
```

Available now-
the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

How to order your ZX81
BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.
BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.
EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
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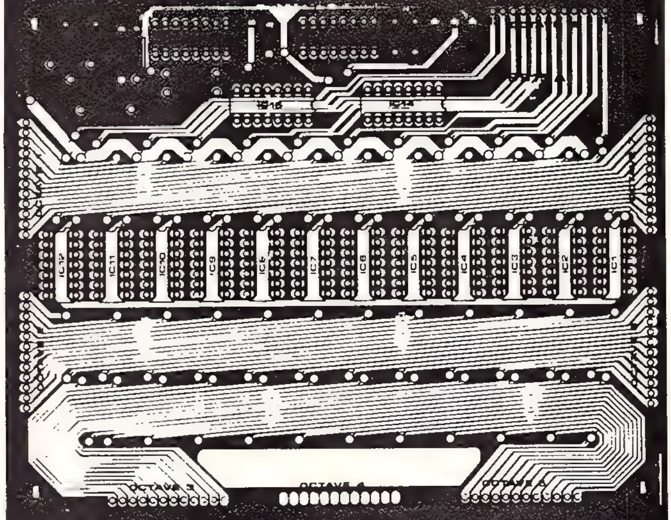

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Many Elektor circuits are accompanied by printed circuit designs. Some of these designs, but not all, are also available as ready-etched and pre-drilled boards, which can be ordered from any of our offices. A complete list of the available boards is published under the heading 'EPS print service' in every issue. Delivery time is approximately three weeks.

It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

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Letters should be addressed to the department concerned — TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered, owing to a lack of practical experience with those other units. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.

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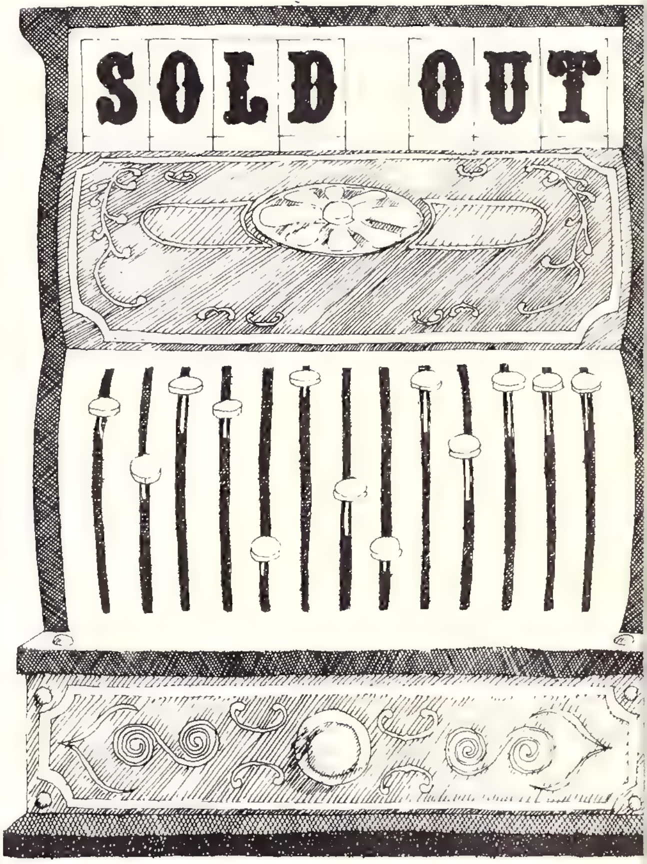

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